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“BRICKLAYING.”

—BY—

OWEN B. MAGINNIS.

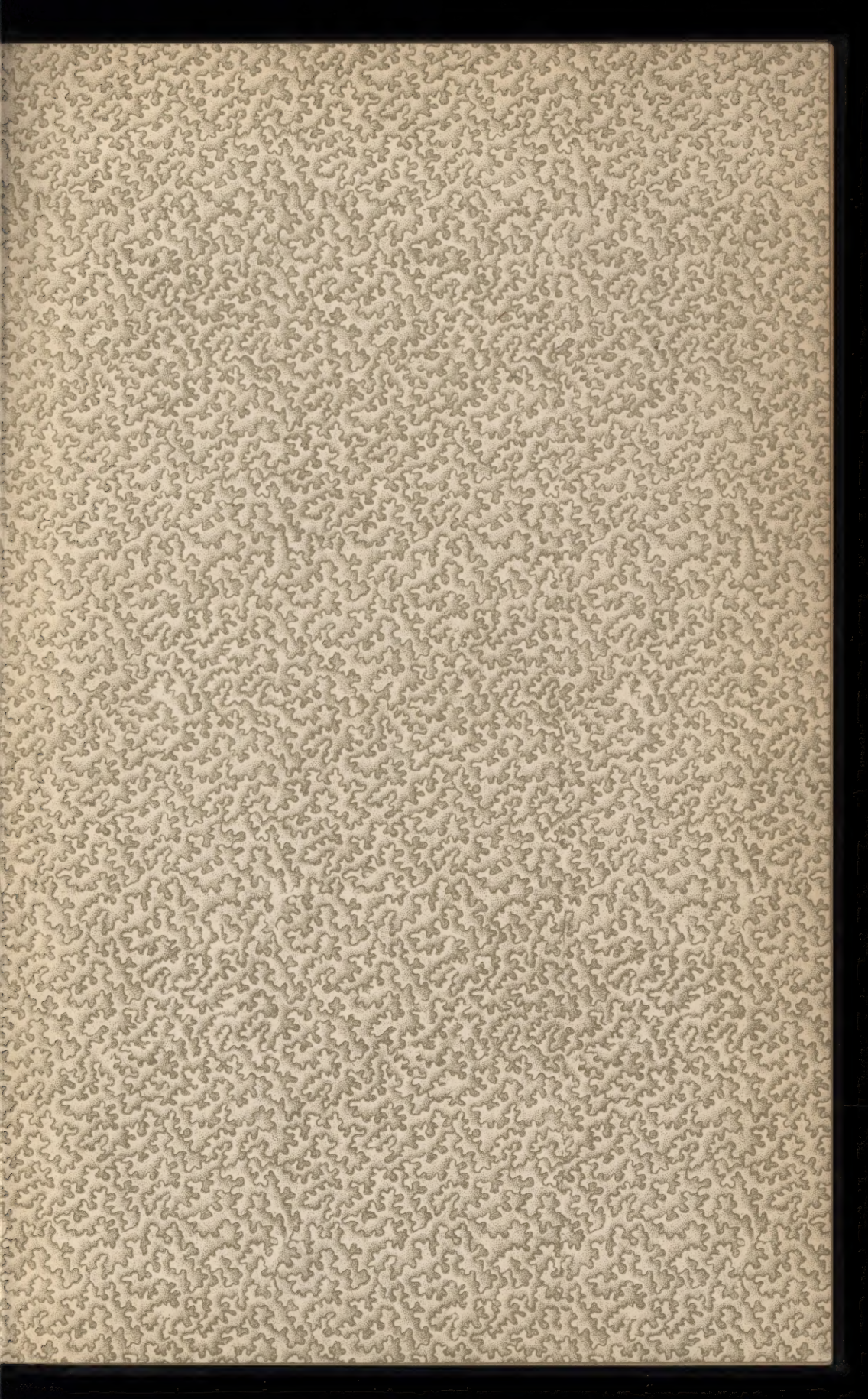
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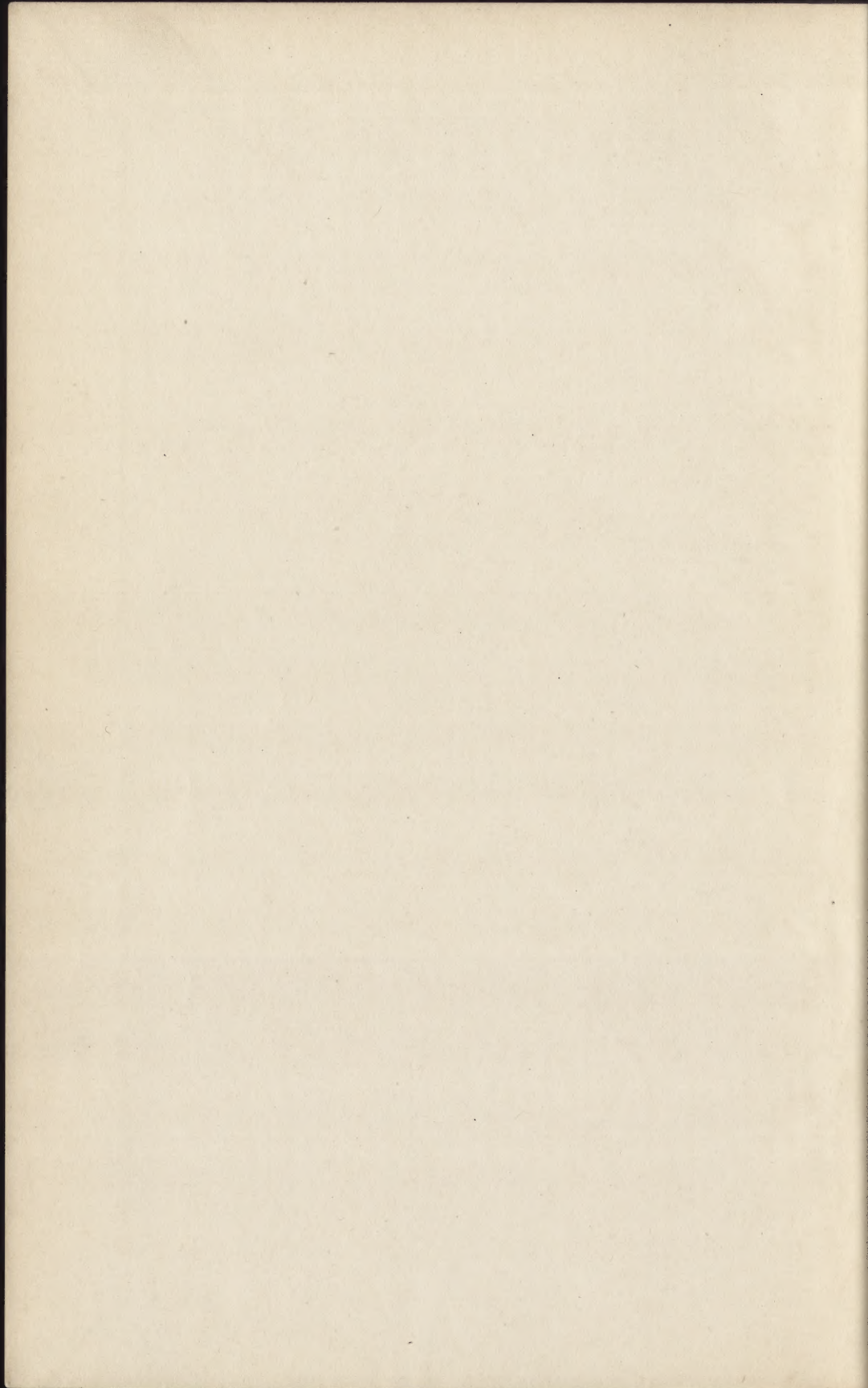
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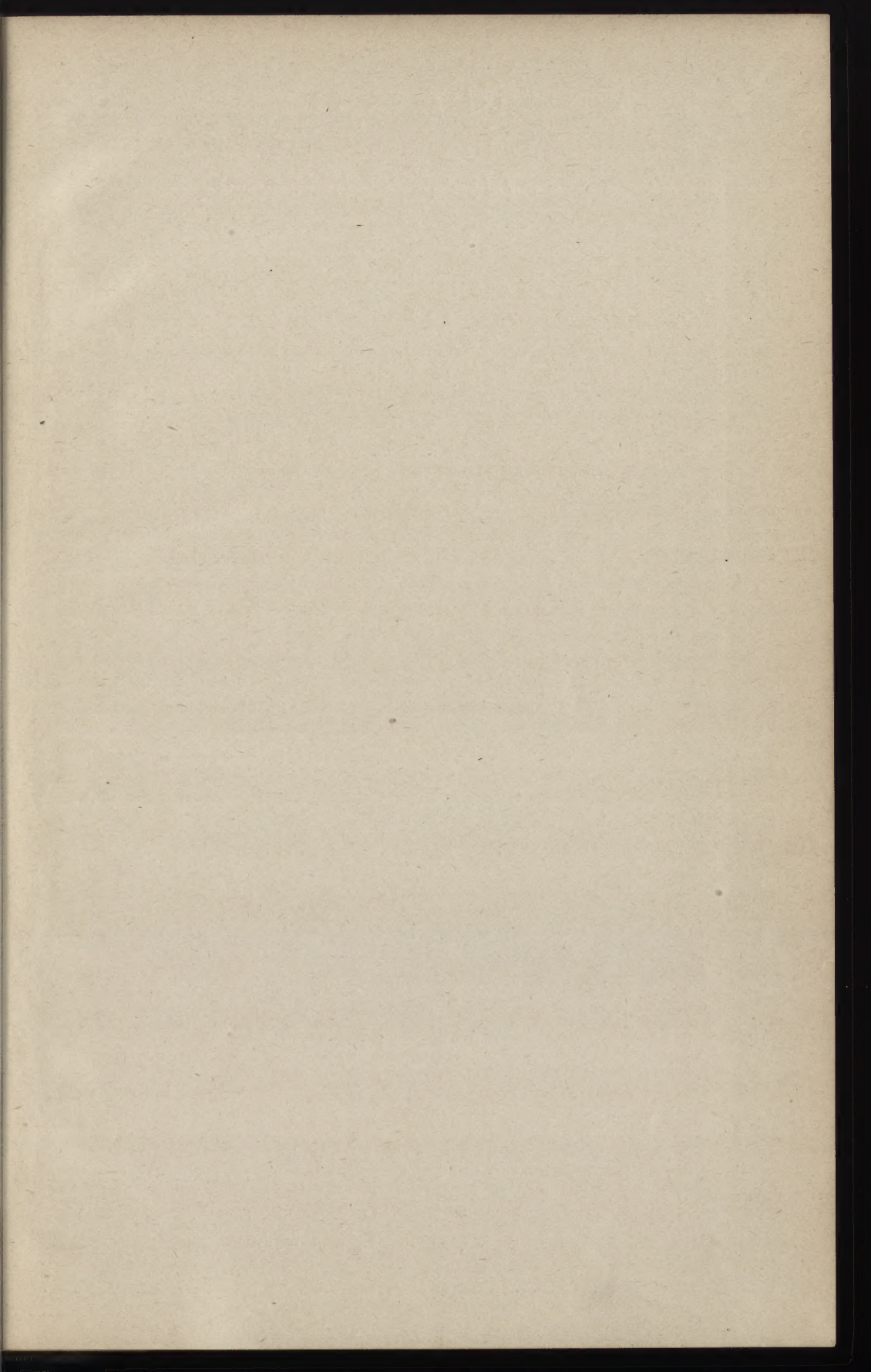
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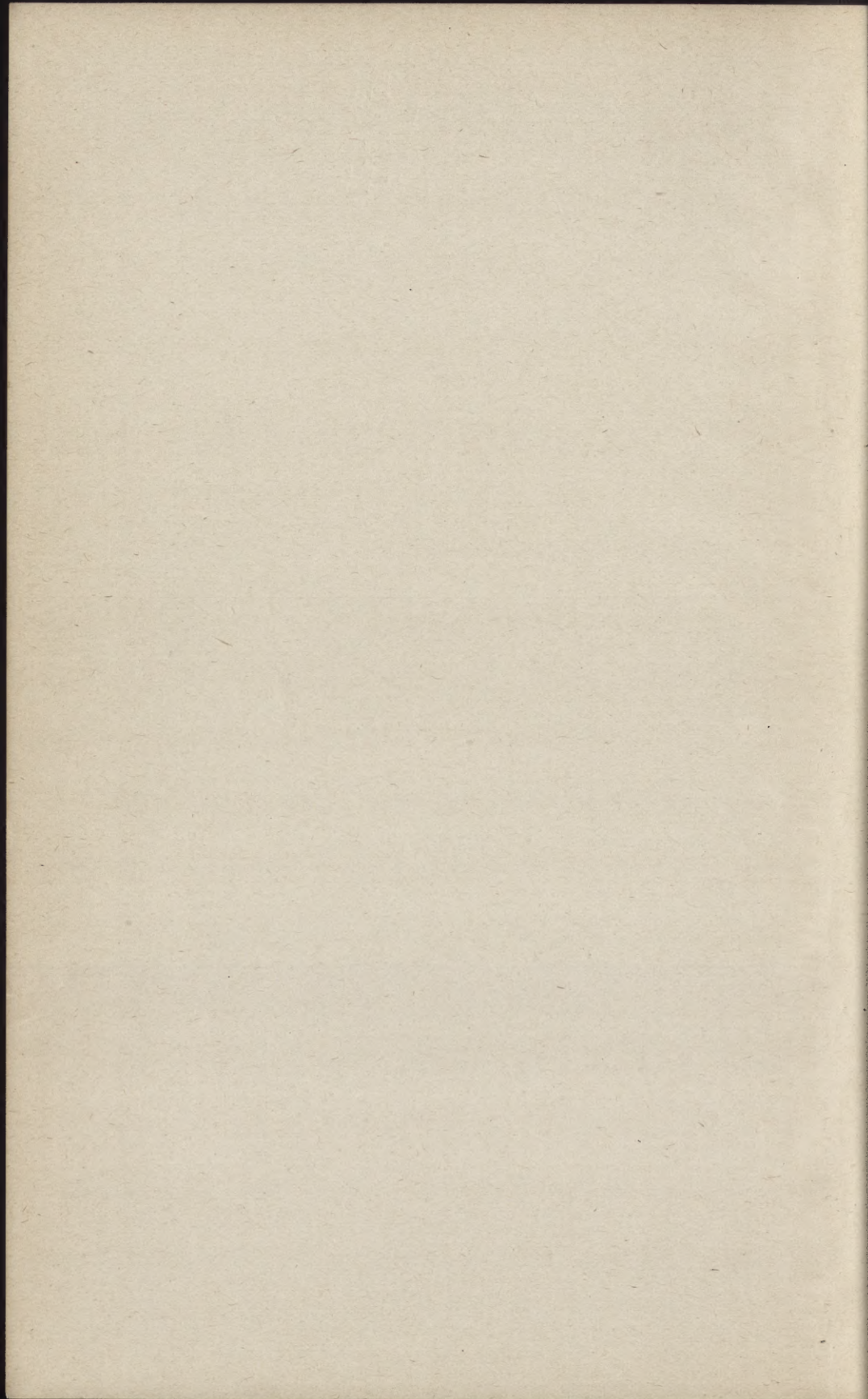
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“Bricklaying”

BY

OWEN B. MAGINNIS.

This book contains extensive detailed explanations of the most approved modern methods of “Bricklaying,” as applied at the beginning of the 20th Century.

The information has been obtained directly from the work, during Construction; and is the Current Practice and experience of the best authorities; supplemented by Chapters on “Shoring,” “Needling” and “Underpinning.” The whole making an invaluable book of reference for Architects, Engineers, Contractors, Builders and Mechanics.

Illustrated by over 200 Engravings with full descriptive text.

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OWEN B. MAGINNIS

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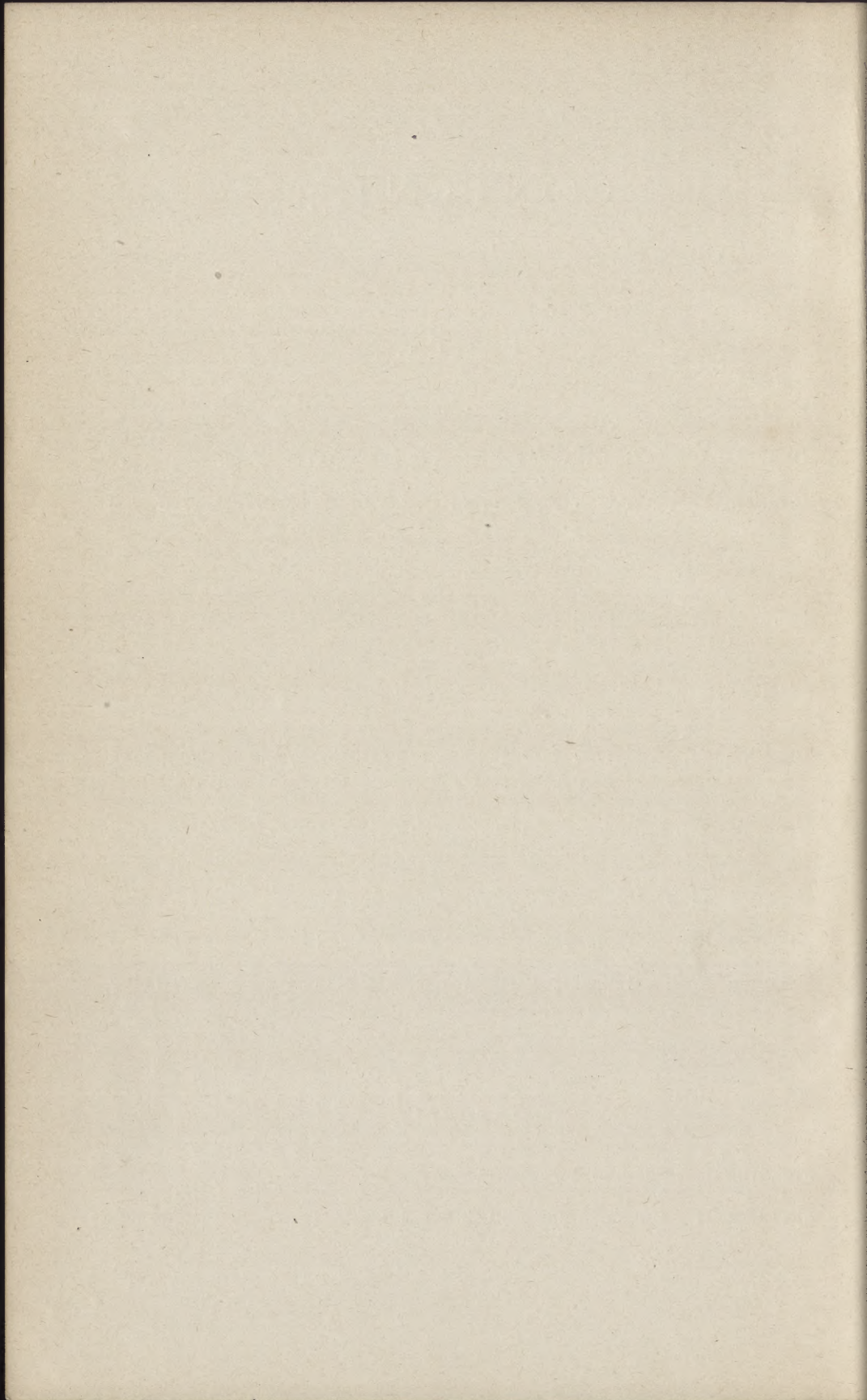
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-

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INTRODUCTION.

IN placing this book before those engaged in the practice of Engineering, Architecture and Building Construction, I do so with full confidence that they will appreciate my work, as such a book is needed.

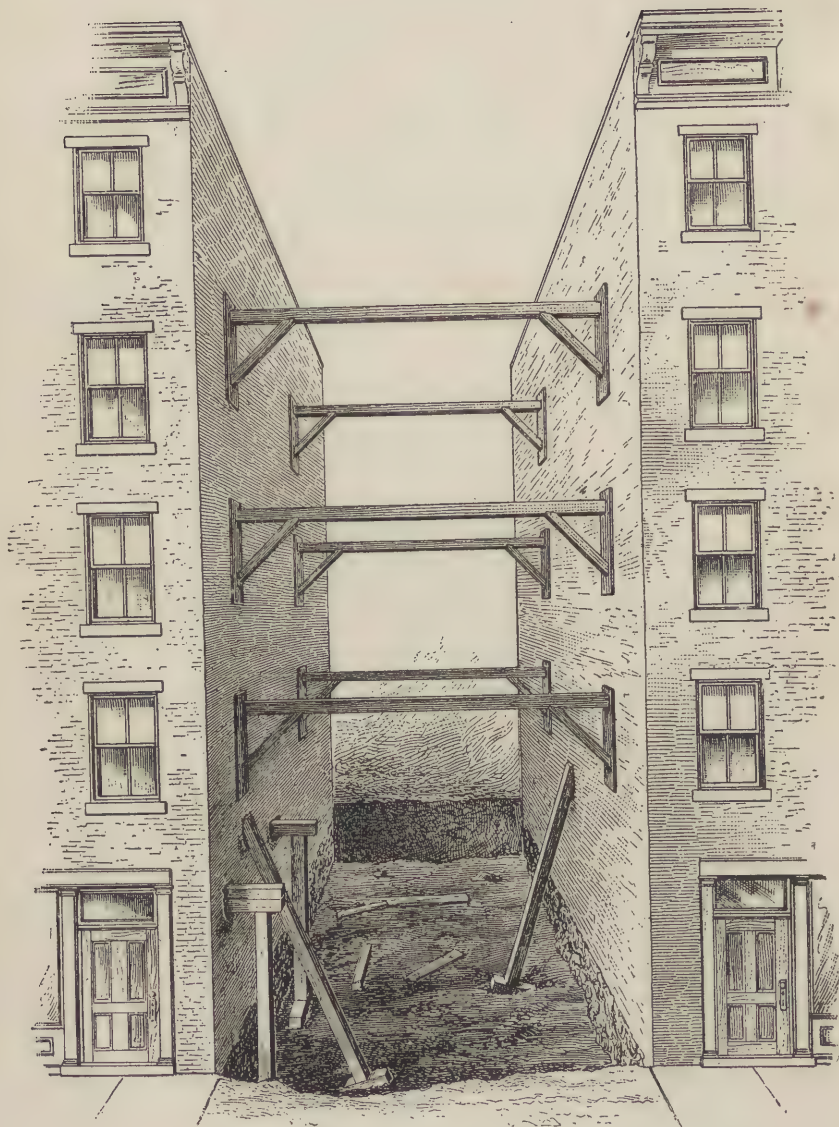
The contents are made up of serial and individual articles written for the most important magazines and journals devoted to the Profession and Trade, and are now collated, revised, edited and published together; with other valuable information, given me by those directing operations. Much, too, has been gathered in my own daily observation and experience in building construction during the past twenty years.

I beg to acknowledge the kindness of the publishers of the *Scientific American*, *Architects' and Builders' Magazine*, *The Carpenter*, *Carpentry and Building*, and *Science and Industry*, who have given me permission to reproduce my articles originally published in the above magazines and journals, and which are, in this book, grouped together so as to be comprehensive and applicable.

My best thanks are extended to those superintending and operative bricklayers whose suggestions have enabled me to make the book practical and thoroughly valuable.

OWEN B. MAGINNIS.

NEW YORK CITY, January 1st, 1901.



FRONTISPIECE. (See Fig. 3 in Part II.)

Bricklaying.

CHAPTER I.

BRICKLAYERS' TOOLS AND THEIR APPLICATION.

THE building of walls of bricks or cubes of clay, united by lime or cement mortar, constitutes "Bricklaying;" an ancient art, the origin of which dates back to the remote ages of antiquity, when bricks were at first laid, unburnt; and it is

ture in the construction just described, is, that a layer of crushed reeds mixed with bitumen was laid over every seventh course. Similar bricks to these were employed by the Egyptians, but there are no remains of brickwork in Greece. Bricks were used largely in ancient Babylon, and in the palace of Nebuchadnezzar bricks have been found covered with enamels of the brightest and liveliest colors.

In ancient Rome burnt bricks are considered to have been first used in the

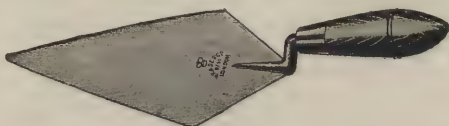


FIG. 1.

supposed the ambitious "Tower of Babel" was constructed in this manner. In the ruins of the earlier constructions

Pantheon of Agrippa, and both triangular and square bricks have been found there. In Roman ruins of antiquity,

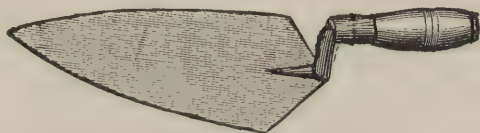


FIG. 2.

of man, the bricks were found to measure about 12 inches square and 4 inches thick, united by mortar or cement com-

backings of small rubble masonry were used with brick facings, the bricks being right-angled triangles of which



FIG. 3.

posed of earth and bitumen. This system is said to still prevail in the neighborhood of Bagdad, and a strange fea-

ture the greatest side was that next the face of the wall, and the right angles bonded into the rubble work by having the

BRICKLAYING.

spaces filled in with stone. This method of bonding face brick somewhat resembles our modern method, which involves clipping the corners of the face bricks and laying the backing course diagonally.

Before commencing to explain brickwork in its application to walls of various thicknesses, I will give some idea of the attitudes and actions of the bricklayer at work and explain the different tools and appliances used in bricklaying.

The first and most essential tool the bricklayer uses, is, of course, the Trowel. This tool of ancient adoption is at this end of the 20th century, manufactured to the shapes shown in the engravings, Figs. 1, 2 and 3. Fig. 1 is the famous London pattern or Brades' trowel. These trowels weigh from $1\frac{1}{4}$ to $1\frac{1}{2}$ lbs., are of splendid steel, and well tempered and balanced, so as to be easily handled and used. Some American bricklayers prefer the Philadelphia pattern, Fig. 2, as the weight of the blade is carried well back to the handle, and being broader is better adapted for lifting or spreading mortar and cutting bricks. The round heel trowels, Fig. 3, are not very popular, but are excellent for cutting, and many good bricklayers prefer them.

In order to use a trowel properly, it should be held firmly yet loosely, with the full grasp of the right hand and applied with the play of the muscles of the arm, wrist and fingers. Only actual

done with the muscles of the forearm, the trowel being held in the position represented at Fig. 5, which shows the



FIG. 5.

hand and arm of the bricklayer when about to push his trowel into the mortar tub. When depositing the mortar on

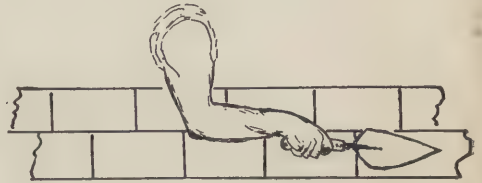


FIG. 6.

the wall, he turns his trowel upside down, and immediately after his arm assumes the position Fig. 6, in order to spread the mortar over the surface of

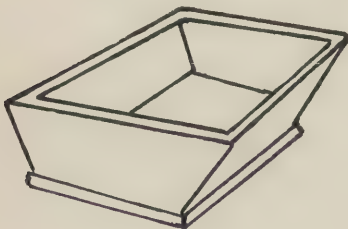


FIG. 4.

practice can give the various mechanical movements requisite, so that in describing them I will illustrate some positions showing the practical application of this tool.

Lifting a trowelful of mortar from the tub or mortar board, seen in Fig. 4, up to the courses of brick on the wall is

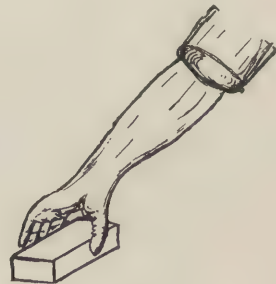


FIG. 7.

the bricks. When lifting a brick from the pile on the ground or scaffold in order to place it on its bed of mortar on the wall, he stoops and grasps it in his left hand in the way illustrated by engrav-

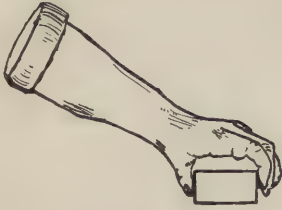


FIG. 8.

ing Fig. 7, and lays it on the wall in the manner seen at Fig. 8. If the brick is laid in a centre or inside course or line,

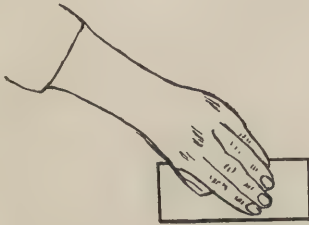


FIG. 9.

he pushes or shoves it down in its bed of mortar with his fingers, Fig. 9, tapping it down when necessary with the edge



FIG. 10.

of the trowel, held in the right hand, in the position Fig. 10, which position is also assumed when he is clipping or cutting a brick with its edge.

Continuing the description of brick mason's trowels which usually measure from 10 to 13 inches in length, the 10-inch being most generally used, I would now draw attention to the five various forms represented at Fig. 11. These trowels are used for pointing and striking up joints and removing the mortar from the face of the brickwork to make a neat, clean job. They measure from 4 to 7 inches long, and are applied with

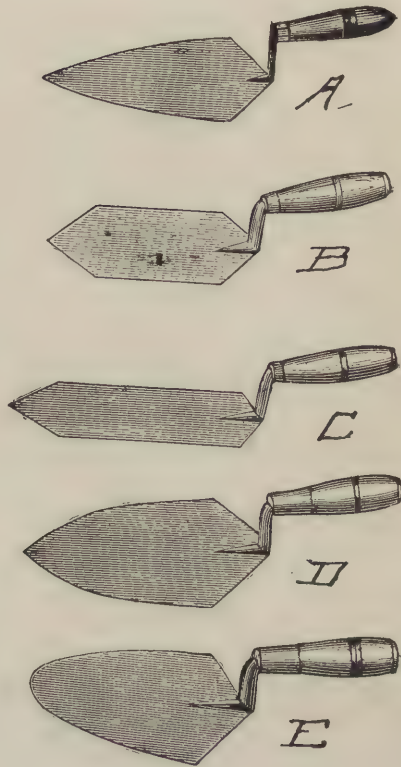


FIG. 11.

the muscles of the fingers and play of the wrist as before described.

As bricks are hard substances and can only be cut into lengths or parts by the action of percussive force, bricklayers follow two methods in cutting them. The first is by a series of rapid blows given with the edge of the steel trowel, as represented at Fig. 10, and the other is by applying a brick-cutting chisel,

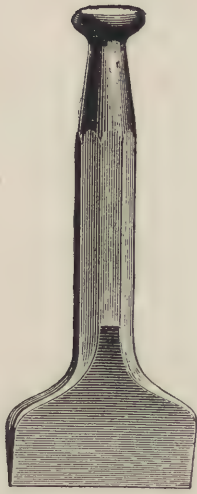


FIG. 12.

Fig. 12, which, with the aid of a bricklayer's hammer, Fig. 13, applied to its

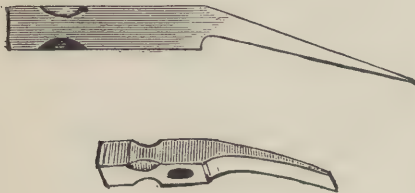


FIG. 13.

end in a series of blows cuts each brick to an exact size indicated on the surface of the brick by a mark. Sometimes the



Double Edge Brick Hammer.

FIG. 14.

chisel pene of the hammer or the double pene hammer, Fig. 14, is used for cutting rough bricks, though nowadays only on front bricks, as the trowel serves this purpose more readily and the ham-

mer and chisel are employed on front bricks, which always require to be cut to neat sizes; being of a very hard composition are brittle and liable to fracture at the wrong place and spoil the brick. Brick chisels are manufactured from $2\frac{1}{2}$ to $3\frac{1}{2}$ inches in width and are ground to a wedge-shaped chisel point. They are held in the left hand when applying the hammer, which weighs from 1 pound 8 ounces to 2 pounds 8 ounces, being wielded with the right hand. For cutting through brick walls the cold chisel, Fig. 15, is used with the hammer, Fig.



FIG. 15.

13, and for drilling holes in brick walls the diamond-pointed drill, Fig. 16, is best adapted, which, after each blow of



FIG. 16.

the hammer is turned to the right to loosen the point in the materials of the brick where it has been driven fast by the impact of the hammer.

As bricklaying is a skilled art, and as the Bricklayer must be in himself an educated artisan with his brain and body trained to the movements of his muscles, and the application of instruments and tools to the erection of material, so it follows that he must have instruments of precision to ensure the mechanical and statical accuracy of his executed work. For this reason long usage and experience have given him a standard set of tools and implements which I am now describing as they occur in actual practice, so under the head of "Tools and Accuracy," I will now explain the value of the Straight-Edge Line, Level, Plumb Rule, Square, etc.

The Straight-Edge.—Figure 17 is a long piece of selected pine wood, $1\frac{1}{8}$ to $1\frac{1}{2}$ inches thick, 6, 8 or 10 inches wide, and from 10 to 16 feet long, and made to the exact shape delineated in the sketch. Its use is to level between points, the ordinary spirit level being placed on the top edge and the ends of the straight-edge—being set on the

points to be leveled, as A and B, Fig. 17. By raising or lowering one

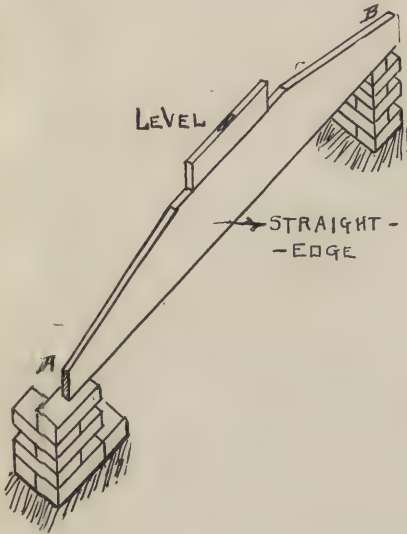


FIG. 17.—BRICKLAYERS' STRAIGHT-EDGE AND LEVEL.

end or the other till the drop or bubble in the glass tube of the level is exactly in the center, which will make the straight-edge perfectly horizontal, then the two points will be level.

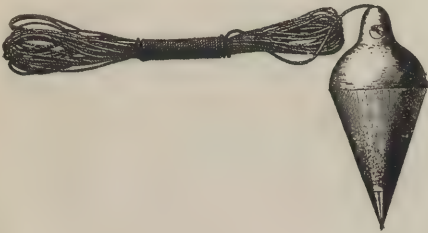


FIG. 18.—PLUMB BOB AND LINE.

When the first courses of brick are laid on a leveled surface such as a water table, line of steel girders or any other horizontal surface, it is the practice to keep each course straight and continuously level by placing a line on each corner and when it is stretched tight to carry up the wall to this line by keeping the upper outside arrises on the edge of

each brick exactly to the line. This valuable instrument with a "Plumb Bob" attached to it is illustrated at Fig. 18. It is simply a stout white whipcord long enough to reach over the extreme length to be built, which can be purchased in hanks or lengths of 25, 50, 75

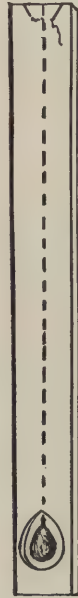


FIG. 19.—PLUMB RULE.



FIG. 21.—THE STANLEY PLUMB RULE AND LEVEL.

or 100 feet as needed, and the object of the conically-shaped solid of brass, termed a "Plumb Bob," shown in the engraving attached to the line, is to weight the line and keep it stretched tightly when dropped down from a height, when it is desired to determine if a wall or corner is "plumb."

The indispensable tool, termed a "Plumb Rule," with its line and plumb bob, is shown in the sketch, Fig. 19, and, like the straight-edge, it is formed of a piece of $1\frac{1}{8}$ -inch white pine, 4 or $4\frac{1}{2}$ inches wide and from three feet six inches to four feet six inches long. With the aid of this tool the bricklayer lays his bricks to a plumb or perfectly perpendicular surface or angle, and in

order to make clear the use of this tool. I will now explain what is meant by this term, which, though very common in mechanical phraseology, is not properly understood by the majority of mechanics:

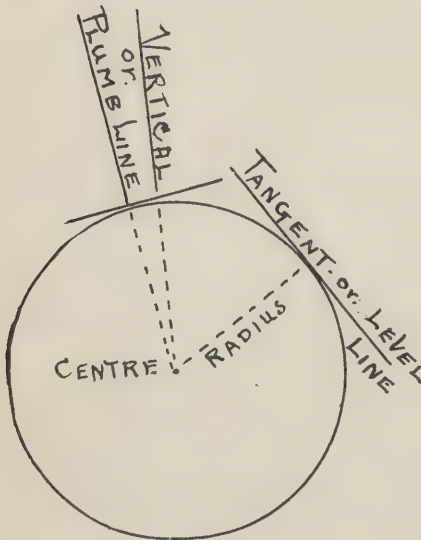


FIG. 20.—DIAGRAM SECTION OF THE EARTH'S PLUMB AND LEVEL LINES.

As it is now almost an established fact that the outer surface of the earth on which we live is curved or globular, it follows that all lines drawn perpendicular to a tangent to this surface, will, if continued down far enough, meet in a common point termed its centre, so that the lines of corners of walls if continued down would meet at the centre of the earth, see Fig. 20. Similarly if carried up to an extraordinary height they would gradually spread apart, or the space between the inside surfaces of the walls would widen as the height increased, and the walls would not be parallel to each other. It might be here stated that walls are not exactly parallel when carried up exactly plumb, but the earth's surface is so vast that the difference is unappreciable. Again, the component parts of walls are kept together by the "Attraction of Gravitation," which is an unseen force contained in the earth which pulls all bodies great or small to its surface, directly at right angles, so that if a line be attached to

any body with a swinging weight attached to one of its ends, as a plumb bob, that weight or plumb bob will slowly gravitate or swing until it stops and the line will hang plumb. This not only happens when a line and bob are attached to an object as a tree post, column, etc., but bodies such as walls



FIG. 22.—STEEL JOINTER USED FOR POINTING JOINTS IN FACE BRICK WORK.

can be, and are constructed plumb, with the bob and rule, Fig. 19. Here the same principle prevails, the rule being a piece of good clear wood about $1\frac{1}{2}$ to $1\frac{3}{4}$ inches thick, 4 inches wide, and from three feet and six inches to five feet long, made perfectly parallel and out of wind or flat and is gauged with a scratch line in the centre. Near the bottom an oval hole is cut in which the lead bob gravitates or swings on a line fastened to the top in the saw cut or slot seen in the engraving. To build a wall plumb, it is only necessary to place the right or left edge of the rule, allowing the bob to swing against any of the vertical edges or faces; carefully watching the bob when it swings backwards

and forwards so that the cord line exactly strikes the gauged line on the face of the rule; when it does this the

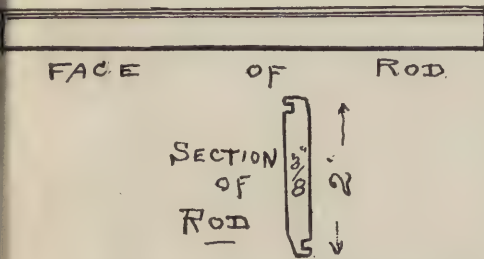


FIG. 23.—HARDWOOD ROD FOR MAKING "RODDED JOINTS."

edge or face of the wall is plumb as desired. Great care should be taken to get the bob as steady as possible. Fig. 21 is an improved form of plumb rule and level, and contains a level and plumb in glass tubes placed in the openings, the glass tube being set perfectly at right angles to the edges.

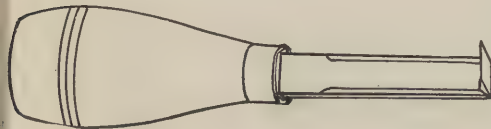


FIG. 24.—KNIFE OR "FRENCHMAN" USED IN MAKING "RODDED JOINTS."

The steel jointer, Fig. 22, is used for tucking or jointing the mortar joints in face brickwork by sliding it along the joint, and as its edge is of an oval or elliptic section it makes a slightly sunken joint of this form. Sometimes the bricklayer uses this tool with the "Rod," Fig. 23, which, however, is generally applied

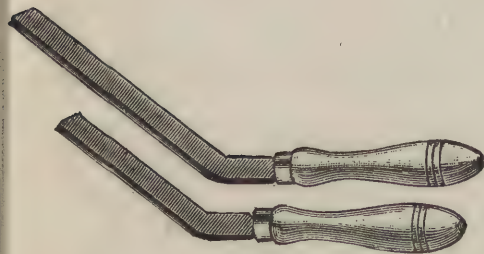


FIG. 25.

when striking "Rodded Joints," which are mortar joints in face brickwork allowed to project slightly outside the face of the work, and are cut to a straight finish with the knife or "Frenchman" seen at Fig. 24, which is simply an old chisel bent to a right angled point and the sides filed to a knife edge. This tool is used like the Tuck-Pointing Tools illustrated in Fig. 25, which are also used on top of the rod for Rodded Joints, and can be purchased to form either a square or oval bead. They are made in the following sizes: Square, $\frac{1}{4}$, 5-16, $\frac{3}{8}$, $\frac{1}{2}$ inch; round, 3-16, $\frac{1}{4}$, 5-16, $\frac{3}{8}$, $\frac{1}{2}$ inch.

CHAPTER II.

LAYING OR SETTING OUT THE WORK, MEASURING AND LEVELING.

OBSERVATION of the construction of buildings has shown me that the use of cord lines in the different branches of building is not entirely appreciated nor understood. With a view, therefore, of impressing upon mechanics, especially bricklayers, the utility of this extremely handy tool or appliance and its application in "laying out," I have inserted this chapter.

Geometrically defined, a straight line is simply a longitudinal extension, or the shortest distance between any two points. Mechanically or technically defined, it is a slender string stretched so tight as to be perfectly straight, and the shortest distance from one point or peg or to another point or peg placed at

No.

- 0.
- 1.
- 2.
- 3.



FIG. 26.—SAMPLES OF CORD LINES.

a greater or lesser distance away from it. This quality gives the line its great value to mechanics, and they use it largely in laying out or setting out almost all details of construction. Some of the most used I will now describe and show their practical application.

First, as to the line itself. It consists of a specially manufactured whip cord made in different thicknesses according to the length it must be stretched. At Fig. 26 I show samples of lines which can be purchased in any tool or hardware store in bundles or hanks, Fig.

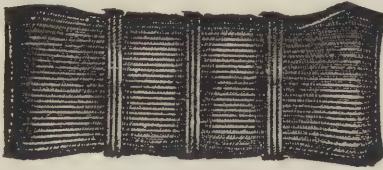


FIG. 27—A HANK LINE.

27, up to 200 feet in length, which is more than sufficient for ordinary work. It is usually kept on a spool or reel illustrated in Fig. 28, and thus conveniently rolled or unrolled as required. As most mechanics are unfamiliar with its use, I will now proceed with its use as

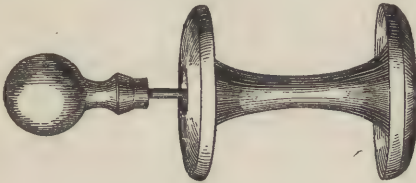


FIG. 28—CHALK LINE REEL.

applied to the laying out of foundations of a building and some of its uses in construction.

Concerning the setting out of the foundation of a prospective building, say, for example, that it is an oblong shape measuring about 25 ft. front by 75 ft. deep, I would say that this is a most important operation and demands the utmost care and accuracy on the part of him who undertakes it. In the cities and small towns or villages each lot is laid out on the city map, and a survey can be made by any city surveyor and a plan of same obtained by the builder, but in the country this is unobtainable, and the builder or bricklayer is compelled to resort to a mechanical process to lay out his site.

The plan followed is very simple. A number of stakes (about eight, if the plan be square or oblong, and more if there be angles or bays on the plan), are sawn out as represented at Fig. 29. These are driven in the ground about on an angle of 45 degrees on the outside

limits of the house measurement, which can be determined with the tape line or ten foot pole in the way illustrated in the sketch, Fig. 30, and across

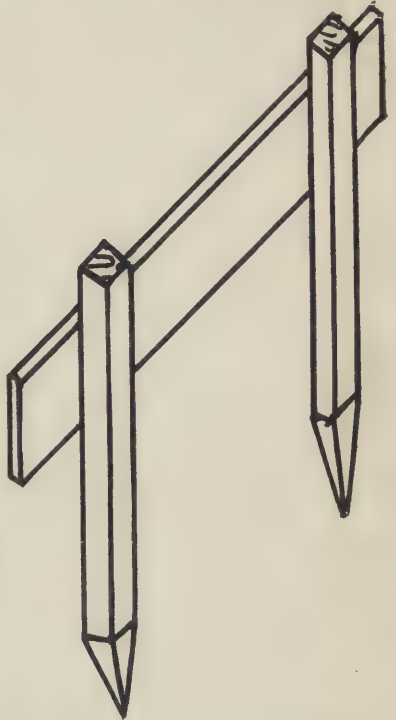


FIG. 29—BATTER BOARD AND STAKES FOR SAME.

these, boards termed "batter boards," are nailed for the purpose of holding the strings and leveling up the lines. The stakes should be of various lengths so as to admit of their being either driven down or raised up when leveling. When laying out, one front corner is first located, and then from this corner the front building line is stretched as A, B. If the lot have square angles one side line as C, D is stretched keeping the angle about square by placing a true steel square inside the lines at the corner, and one man moving the line in and out, while another holds the square till the lines touch the outside edges of the blade and tongue.

Some mechanics prefer to use the old reliable method which I explain by Fig. 31 and which, to my mind, is certainly infallible if accurately done. This

method is to assume any three figures, as 6 feet, 8 feet and 10 feet, then to measure off on one side from the corner 8 feet, on the other side 6 feet, so that when the lines are brought together until the ends of 10 foot pole touch each point, the angle will be a right angle or square. This method is based on a geometrical rule which states—that the square of the hypotenuse of any right angle triangle, is equal to the squares of the other two sides containing the right

wise plan to set one corner level with the top of the curb. This can be done by carrying it over on a straight edge, and having made the corner level to sight along the line of one side, and the edge of the straight-edge till the line is

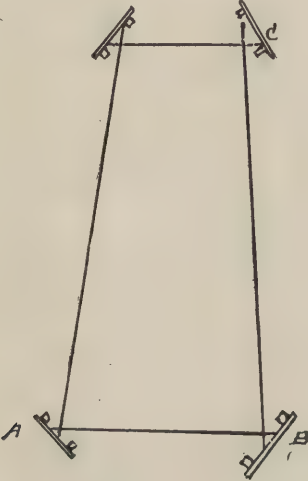


FIG. 30—BATTER BOARDS AND LINES STRETCHED FOR EXCAVATING.

angle. This, in its practical application to the corner, as applied arithmetically, is worked out thus: 8 feet multiplied by 8 feet=64 feet; 6 feet multiplied by 6 feet=36 feet; 64+36=100 feet; 10 feet multiplied by 10 feet=100 feet; so that 8 squared + 6 squared=10 squared.

In formula, this reads:

$$8^2 + 6^2 = 10^2.$$

When the two lines are stretched and the square corner obtained, the opposite sides are measured parallel, and the exact sizes determined thus, giving the surface measurements of the ground plan.

But the surface of the ground is uneven and out of level, and in order to carry up the different details of the building level we must make sure that the lines are also level. All bottoms or footings in cities or towns are supposed to be set so many feet below the curb line of the sidewalk. It is, therefore, a

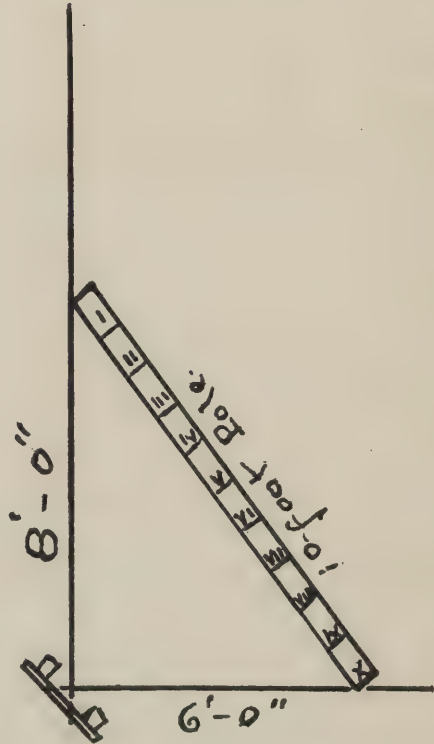


FIG. 31—CORNER SQUARED BY FIGURES. $6 \times 8 \times 10$.

exactly level. Some prefer to place a straight edge blocked up level under the line and then to raise or lower the line till it touches the edge. This method is very applicable in any location, but requires great care, accuracy and certainty of measurements.

Continuing the practical use of the lines, we will now suppose the excavation of the lot complete and the bottom properly leveled off, lines must be stretched to locate the trenches and the position of the piers and intermediate walls. Fig. 32 will convey a full idea of the application of the lines in obtaining the exact situation of the piers, and great care must be exercised in doing this for the reason that any mistake

made in the footings or foundation walls in regard to their position, must change the layout of the whole plan and be carried up through all the stories. Every foundation must, of course, be laid out from the foundation plan or cellar plan, and the *layout*, that is to say, the location of each pier, wall, etc., must be absolutely correct, for, if it be not correct, then all the lengths of beam girders, etc., will be changed according to the error, and the result is

intermediate walls, these should be located by centre lines, that is, by cord lines stretched from one side of the lot to the other side and a plumb bob hung on the line reaching down to the bottom of the excavation. The bob will give the exact centre point, and half the thickness of the wall is measured off on each side. The same operation is gone through on the opposite end of the wall and then a short section is built and the guide lines stretched to

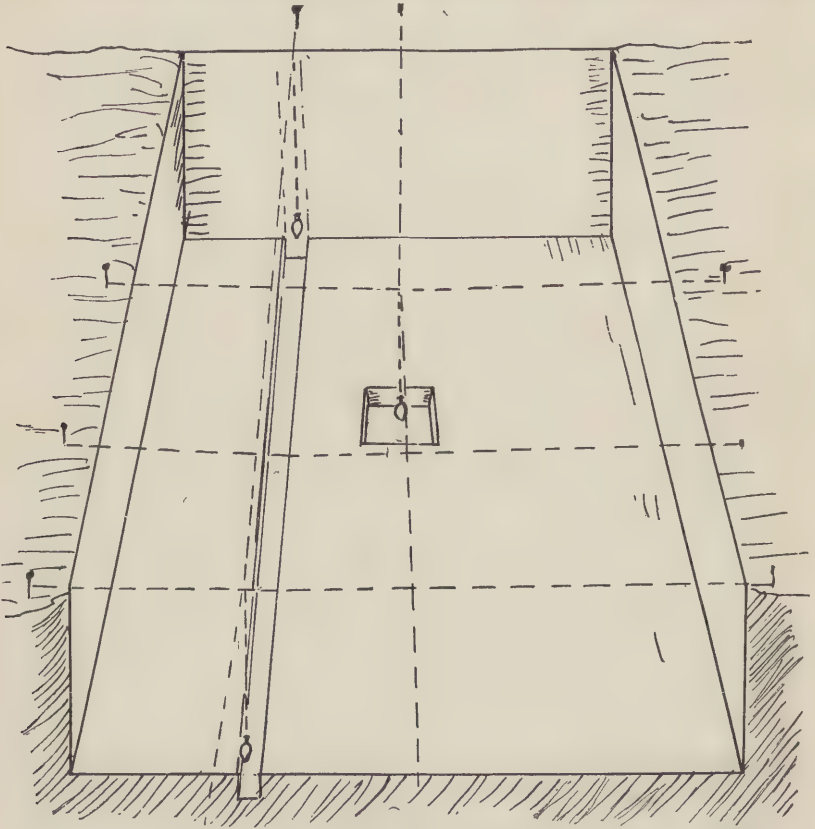


FIG. 32.—SECTION THROUGH EXCAVATION SHOWING USE OF LINES.

trouble to all concerned. However, the application of the lines makes the laying out a comparatively easy task, provided care and accuracy are exercised. For this reason this job should be done from the plan, as I find that masons are sometimes, a little careless in the *measurements*. In regard to the outer walls. These are best built from lines stretched on their outside finished faces, so that all the work will come inside of them. If there be inside or in-

guide the work straight. For piers the method used is to measure on opposite banks or sides of the excavation and cross or intersect two lines directly over the central point of the proposed pier, then, by hanging a plumb bob and a line from this intersection, the central point at the bottom can be marked and the size of the pier laid out from it on each side half the thickness of the footing of the pier. By following this method,

especially in the case of a very deep cellar, the bottom of the excavation inside the banks can be laid out with almost absolute accuracy. But, as I stated before, the measuring should be slowly and carefully done, by the bricklayer using a steel tape line, and proving his marks by remeasuring before the work is commenced.

Concerning the levels of the details inside the excavation, I would state, that the safest way to obtain these is

ordinary spirit level placed on its top edge. But bricklayers should make absolutely sure that the straight-edge is exactly parallel as should it taper or diminish towards either end, it will, as a consequence, give incorrect levels. When level points or surfaces are found they should be made permanent by using a heavy stone or driving down a stout stake. When foundation walls and piers are built, and there is to be a frame building or

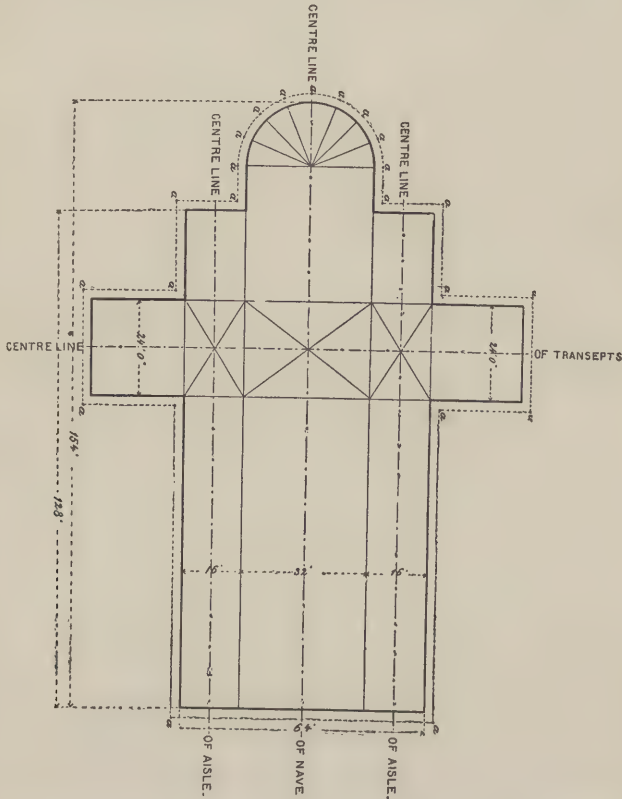


FIG. 33.—GROUND OUTLINE PLAN OF A CHURCH, SHOWING CENTRE LINES.

(if the excavation or area of the building be large, say 75 x 100 feet or over) to use a revolving spirit level and rod with a telescope mounted on a tripod. This valuable instrument can be set with the plumb bob, indicating the centre of swing on the centre of a pier and by revolving it around with a rod man holding the rod where required, but if this instrument be not available, the levels may be found with a long straight-edge having the

superstructure raised upon them, no one should ever rely on their tops or upper surfaces being exactly level, as experience will show that in many cases bricklayers or stone masons, except in the case of unusually good work, do not carry their courses up level. So that, before commencing the superstructure the top of the wall should be gone over with the spirit level, and its possible inaccuracy discovered, and, should any angle or corner be low,

slate or stone blocking should be used to raise it up level.

At Fig. 33, I give the ground layout or staking plan of a large church with nave aisles and transepts also with an "apse" or circular end. The points *a, a, a*, represent wood stakes driven into the ground to which cord lines are attached and stretched from stake to stake 12", away from the outside basement wall line of the intended building. This will show how requisite lines are in laying out and how careful men should be in placing them.

instruments most popular for leveling in laying out large works are the engineer's transit, theodolite or architect's Y level, all of which are of the utmost utility for mechanical operations. However, the form of improvised water level shown in our engraving is, perhaps, most adaptable, as it can be easily and cheaply made, is accurate in its action and simple in its application. As will be seen, it consists of a long piece of ribbed rubber hose or pipe, half an inch internal diameter, with pieces of transparent glass tubing, twelve or

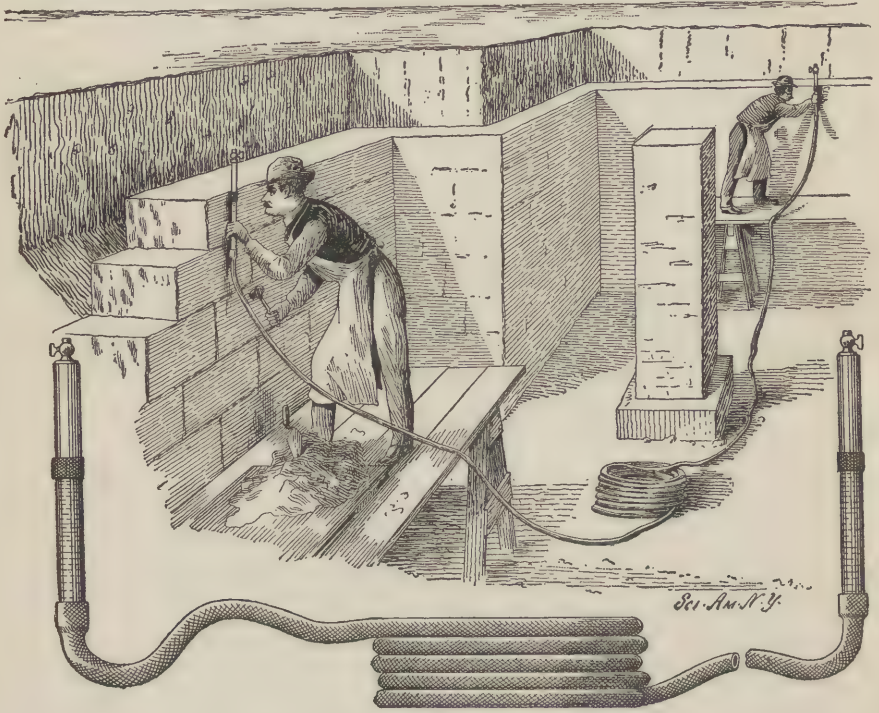


FIG. 33 X.—A SIMPLE HYDROSTATIC LEVEL.

THE PRACTICAL APPLICATION OF THE HYDROSTATIC LEVEL IN BUILD- ING CONSTRUCTION.

The science of modern building construction necessitates the introduction of such instruments, tools, and appliances as will expedite the work and lessen expense by economizing time. Such an implement is the hydrostatic or water level, shown in the accompanying drawing, Fig. 33 X. The

eighteen inches long, inserted in each end. These glass tubes should, if obtainable, be graduated into inches and parts of inches down to sixteenths, but if graduated tubes are not to be had, smooth tubes of clear thick glass of chemical tubing will do, and a quarter or half-inch section can be cut off the end of the rubber pipe and set over the glass tubes, which will slide up or down so as to form a gage.

Water is poured into the rubber hose pipe and glass tubes till the ends over-

flow, when they are kept full by placing a small tip or faucet at the ends of the tubes, as shown. When in use, the faucets must be opened in order to allow the water to find its own level. One glass tube is placed against the wall which has been built to the required height, being held firmly against the face of the wall with the gage set four, six or eight inches from the top as desired, the gage being kept at the edge of the brick or stone wall templates from which the required level is to be measured. Here it is held by one man, while another carries the other glass tube to the object to be measured. When the water is exactly on the line of the gage, the level point is determined, and the distance of the detail above or below the gage will denote the discrepancy in the relative heights. This will be readily understood from the engraving, where this simple instrument is represented in use as setting the levels on top of a foundation wall for templates for iron beams, or in a position where the transit or Y level and staff would not be so convenient or so applicable. Many masons use this instrument with a rod for finding depth of trenches for walls, piers, etc., for leveling for templates, sills, water tables, or other details, especially in an excavation which is crowded with piers, shores, derricks or appliances, which, of course, render the use of the transit or Y level impossible.

CHAPTER III.

MIXING CONCRETES AND MORTARS.

We will now take up the subject of mortar, dealing with it entirely from a practical standpoint, avoiding all scientific detail, and commencing with Lime Mortar.

This mortar is made by bricklayers' laborers, who, first, on a platform of planks form a shallow basin of screened sand taken from and close to the sand pile. Into this basin they dump one barrel of lump lime, and on this dumped lime they pour water until the lime is thoroughly slaked, or the action of the water expels the carbonic acid gas remaining in it after "*calcining*," for lime is made from calcined limestone. In the sand basin it steams and boils, when being slaked, and it will require to absorb one quarter its own weight of water before it is thoroughly slaked,

and will expand to two or three times its lump size.

When the lime is properly slaked it is reduced to a slimy consistency by the laborers, who use the "hoe," Fig. 34, until the lime is entirely free from lumps. While in this state they add from two to five barrels of clean, sharp sand, screened by dashing up against the Sand Screen, Fig. 35, and continue mixing the lime and sand together with



FIG. 34.

the hoe, until each grain of sand is covered with the lime and the whole mass is pasty and workable, under the shovel and trowel. This thorough working and mixing are indispensable to good mortar. When ready, it is shoveled with the shovel, Fig. 36, into the hod, Fig. 37, and then conveyed by the hod carriers to the bricklayers' scaffold and there dumped into the mortar-box, Fig. 4. Lime mortar should never be mixed too thin, and care should be exercised not to use sand too sharp, or sand which has any percentage of loam in its composition.

Cement.—"**Cement**" is a species of lime, which has the quality of hardening or "*setting*" when immersed in water. The principal cements used by bricklayers in building construction are Portland and Rosendale. The first is an artificial composition, made up of chalk and clay, moulded into cubes, burnt in a kiln to expel the carbonic acid gas, and afterwards ground into fine dust or powder. The second, Rosendale, is a natural cement, and is made from limestone, with about twenty per cent. of clay.

Concrete.—This invaluable composition for footings and foundations is mixed by laborers, who form a tight platform of planks, and on this platform spread the ingredients in the following proportions, namely: 4 barrows or barrels of clean, sharp sand, and two of cement, and then with the application of shovels, Fig. 36, work and turn over the two, dry, until they are thoroughly mixed. On this 8 barrels of broken stone are dumped and the combination is again turned over and

mixed, while water from a sprinkler or hose is applied until each and every stone in the entire bed of concrete is covered with mortar. This mixture, being of the proportions of one part of cement to two of sand and three or five

form, one barrel or measure of cement, one to three barrels or parts of clean, screened, sharp sand, and thoroughly mixes the two with the shovel until they only show one color, then he adds the exact amount of water required by

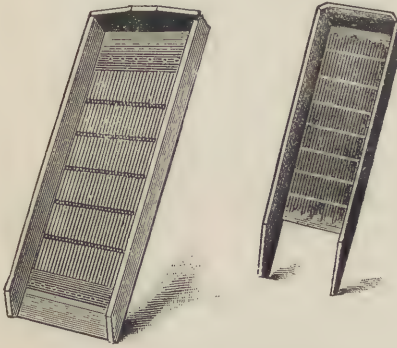


FIG. 35.—SAND SCREEN. GRAVEL SCREEN.

Small size, 22 in. wide, 61 in. long.

Large " 28 " " 67 " "

of broken stone, is then shoveled into the wheelbarrows, wheeled to the trench and dumped from a height and rammed down by men with rammers. It is usually spread in layers running from 4 to 8 inches in thickness, and rammed till the water shows on top of each layer.



FIG. 36.

Cement Mortar.—This is also prepared for the use of the bricklayer by his laborer, who spreads on a smooth plat-



FIG. 37.

sprinkling, and then mixes again until the mortar is brought to the consistency of a plastic mass.

The amount of water required is regulated by the nature of the cement, which can only be determined by experimenting with a small portion, and care should be taken not to use too much water, as this weakens the strength of the cement. The state of the atmosphere also will affect the plastic nature of the mass, also the dryness of the sand.

To get great strength only enough water should be added to make the mortar resemble damp earth. It is always best to mix sand and cement DRY, in their specified proportions before sprinkling.

Cement mortar, whether of Portland or Rosendale, should be mixed in small quantities, and none that has laid or set over night be used.

Grout is a mixture of cement and sand mixed and worked to a thick liquid, which is poured into the brick joints of piers or walls where extreme strength is required. Much difference of opinion prevails as to its true value in giving extra strength, by creating a greater cohesive force, but it undoubt-

edly has the quality of keeping the wall well wet while setting, it enters every hole and crevice in the surfaces of each brick, and promotes a better bond by a fuller absorption of the carbonic acid gas into the cement, which was expelled when the gypsum or limestone, which composes it, was burnt.

Lime and Cement Mortar.—When brickwork is to be laid in this mortar, it should be composed of 3 parts of lime, a large proportion of sand and one part of fresh Rosendale or Portland cement. The lime and sand should be mixed and worked by the laborers at least two days before the cement is added for a final working, before using in the wall. Only small quantities of cement should be mixed at a time, as required, and none allowed to set over night.

When it becomes necessary to use mortar in cold weather the following solution can be advantageously used: When using mortar in freezing weather insert and mix in it 1 pound of salt to 18 gallons of water to form a brine in order to prevent the water in the mortar from freezing, and give it time to form a bond with the bricks. It is, however, a detrimental practice to use salt in mortar, because it absorbs water and keeps the mortar in the wall constantly damp, so that it is best not to lay any brick in very cold or frosty weather.

When mixing "Lafarge" cement, which is used for "setting or backing" up stonework or "face brickwork," the usual proportions are one part cement to two parts clean, sharp sand. For "pointing," one part this cement to one part white sand. This also applies to "Puzzolon," another preparation of cement used for the foregoing purposes. Sand being friable does not shrink, and is therefore adaptable to all mortars, if free from loam, dirt or other injurious materials.

The following sections of the New Building Code of the City of New York, will be found of value, as they embody the results of the very best experience, and the Measures, Proportions and Figures which I have added on, will prove useful in writing specifications:

PART IV. QUALITY OF MATERIALS.

Sec. 13. Brick.—The brick used in all buildings shall be good, hard, well burnt brick.

Sec. 14. Sand.—The sand used for mortar in all buildings shall be clean, sharp grit sand, free from loam or dirt,

and shall not be finer than the standard samples kept in the office of the Department of Buildings.

Sec. 15. Lime Mortar.—Lime mortar shall be made of one part of lime and not more than four parts of sand. All lime used for mortar shall be thoroughly burnt, of good quality, and properly slaked before it is mixed with the sand.

Sec. 16. Cement Mortar.—Cement mortar shall be made of cement and sand in the proportion of one part of cement, and not more than three parts of sand, and shall be used immediately after being mixed. The cement and sand are to be measured and thoroughly mixed before adding water.

Cements must be very finely ground and free from lumps.

Cements classed as Portland cement shall be considered to mean such cement as will, when tested neat, after one day set in air be capable of sustaining without rupture a tensile strain of at least 120 pounds per square inch, and after one day in air and six days in water be capable of sustaining without rupture a tensile strain of at least 300 pounds per square inch. Cements other than Portland cement shall be considered to mean such cement as will, when tested neat, after 1 day set in air be capable of sustaining without rupture a tensile strain of at least 60 pounds per square inch, and after 1 day in air and 6 days in water be capable of sustaining without rupture a tensile strain of at least 120 pounds per square inch. Said tests are to be made under the supervision of the Commissioner of Buildings having jurisdiction, at such times as he may determine, and a record of all cements answering the above requirements shall be kept for public information.

Sec. 17. Cement and Lime Mortar.—Cement and lime mortar mixed shall be made of one part of lime, one part of cement and not more than three parts of sand to each.

Sec. 18. Concrete.—Concrete for foundation shall be made of at least one part of cement, two parts of sand and five parts of clean broken stone, of such size so as to pass in any way through a 2 inch ring, or good, clean gravel may be used in the same proportion as broken stone. The cement, sand and stone or gravel shall be measured and mixed as is prescribed for mortars. All concrete when in place shall be properly rammed and allowed to set without being disturbed.

MEASURES, PROPORTIONS AND FIGURES.

1 barrel Portland cement=4 bushels (nominally).

1 barrel Portland Cement weighs 380 lbs., net.

1 barrel Portland Cement contains about 4 cubic feet.

	Thickness.—		
	1 in.	$\frac{3}{4}$ in.	$\frac{1}{2}$ in.
	yards.	yards.	yards.
1 bushel Portland Cement will cover.....	1 1-7	$1\frac{1}{2}$	$2\frac{1}{4}$
1 bushel Portland Cement and 1 of sand will cover...	$2\frac{1}{4}$	3	$4\frac{1}{2}$
1 bushel Portland Cement and 2 of sand will cover...	$3\frac{1}{2}$	$4\frac{1}{2}$	$6\frac{1}{2}$

Concrete.

1 barrel Portland Cement.

2 barrels clean sharp sand.

6 barrels broken stone or hard-burnt brick or gravel will yield about 20 cubic feet.

Foot Walks.

For bottom coat a concrete of:

1 barrel Portland Cement.

2 barrels sand.

5 barrels broken stone.

For surface:

1 part Portland Cement.

1 part sand.

Artificial Stone and Blocks.

1 barrel Portland Cement.

6 barrels clean sharp sand.

Use as little water as possible, and ram well in metal moulds, if possible to be obtained.

Masonry.

For average masonry of rough stone, contractors estimate about one barrel of ordinary hydraulic cement and two barrels sand to the yard; or of Portland cement about one barrel with two or three parts sand. For granite and cut-stone work the amount of cement is much less, depending on the character of the stone.

CHAPTER IV.

BRICKLAYING AND BONDING WALLS OF VARIOUS THICKNESSES.

TO make a brick wall a strong cohesive and uniform mass, it is necessary that some system be followed in placing its principal component parts, and this is done by following the system termed "Bonding."

The word "bond" in its application to brickwork, signifies the positions in which bricks are placed in juxtaposition with intervening layers of mortar, to form, when the mortar has "set" or hardened a perfectly solid construction, and the manner and methods of doing this constitutes the "art of bricklaying."

* * * * *

As there are essential detailed rules which must be observed to get a good job of brickwork, I will now touch on some of them in the form of axioms.

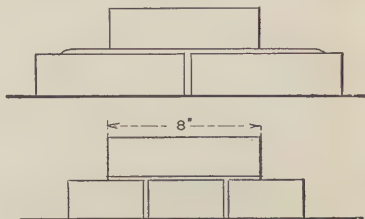


FIG. 38.

These are standard, and the practical and positive results of the best experience:

"The object of bonding a brick wall is to distribute the weight which the wall carries, so that it may be borne by all the bricks and not by a few."

To gain this end, bricks should always break joints like Fig. 38, which shows the first and second bottom courses or the commencement of an 8 inch or 4 inch brick wall, where it will be seen the ends of the bricks do not hang over each other, but "break joint," as it is technically termed by bricklayers. For this requirement, it is therefore necessary to use quarter bricks, half bricks or pieces termed "bats" to keep the joints well broken, which will be understood as the different bonds are explained in succession, but no bond should ever be less than two inches.

When bricks are laid parallel to the face of the wall or longitudinally, they are termed "stretchers," when laid at right angles or across the wall, they are called "headers," therefore, all brick walls should have two bonds, which are indispensable, namely, a "stretcher" bond lengthwise with the wall and a transverse Header bond, extending across or through the wall.

Every wall should invariably be built "plumb," like Fig. 39, on both the in-

side and outside faces, the plumb rule and line being applied both on the inside and outside, and no wall should ever be laid up in the irregular unwork-

should be well rubbed down into the mortar when it is laid. Bricks, if too dry, should be wet, as all bricks when

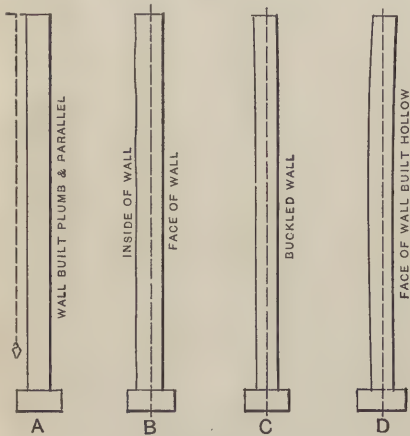


FIG. 39.

manlike manners represented in the three sections, B, C and D, shown at Fig. 39. All walls should be carried up by the bricklayers with the courses



FIG. 40.

level and straight from corner to corner by working to a line and occasionally leveling the courses, especially where window sills and other openings occur. All mortar joints should, as far as possible, be kept the same thickness, and should never be allowed to become uneven or "Hogged," which happens when laying brick overhand, or without a line. Should the joints be laid too wide or vary in width, they are liable to compress or squeeze together under the weight placed upon them, and cause the wall to settle, buckle, or fracture, when it is settling to its natural bearings.

As bricks are held together by the cohesive action of the mortar, which must cover all surfaces to obtain the most perfect bond, it follows that each brick

be dispensed with, but they should never be wet in freezing weather as the water forms an icy film on the surfaces of each brick.



FIG. 41.

dry, even in cold weather, will suck the water out of the mortar and leave only the lime and sand, which will set or harden without absorption, and have no bond. When the atmosphere is humid or damp, wetting the bricks may

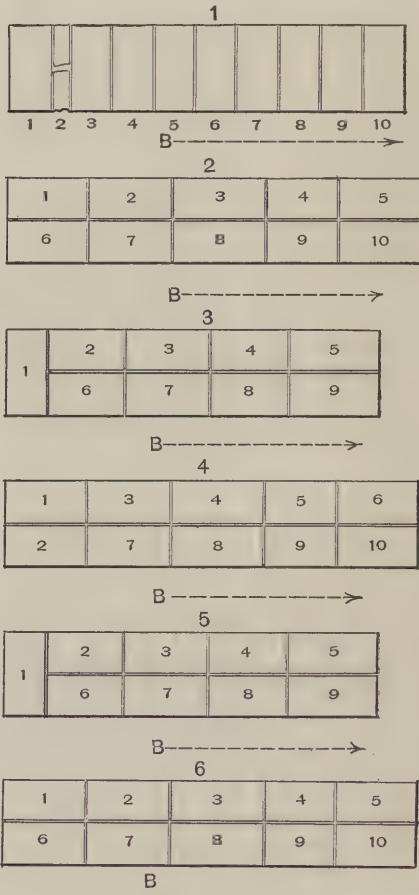


FIG. 42.

All joints around window or door frames and all interspaces in brick walls, should be thoroughly "slushed" up with mortar and filled in with pieces of brick to get a good, solid air tight construction; and if a wall has been uncovered and not been built on for some time, it should be well scraped off and swept clean to remove all dirt or other foreign substances from the top surfaces of the bricks. To prevent rain, snow or any injury to a wall in course of construction, good bricklayers cover the top courses of their walls with boards or planks to preserve them over night, and if they are to remain unbuilt on for a long time, as in very cold winter weather, they carefully cover them with tarpaulins, canvas or tar paper, and weight these down with planks on top, thus protecting the wall from injury.

All brickwork into which frost has entered should never be built upon, but be pulled down and rebuilt.

Frozen walls are liable to slide or buckle.

In order to get the best results when rough or common brick walls are being laid, the following simple details should also be observed and followed;

Each brick should be laid with a shoved joint, in a full bed of mortar, all intersections being thoroughly filled and where the bricks come in connection with anchors, each one shall be brought home and close to same, so as to do all the holding work possible.

All mortar joints, where the wall is not to be plastered, should be neatly struck with the trowel, and all courses kept level and the bonds preserved.

Where necessary to bring any course up to the required height "clip"



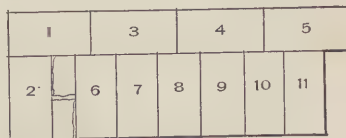
FIG. 43.

courses should be formed, and in no case should any mortar joint finish more than half an inch thick.

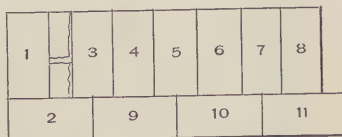
All bricks should be laid to lines, and all wall spaces, angles, chases and intersections, etc., built plumb true and square; also all walls must be leveled to receive girders and floor beams, where they occur.

The usual average size of common or rough brick is 8 inches long, $3\frac{1}{2}$ inches wide and 2 to $2\frac{1}{4}$ inches thick. These

should be of good porous clay and be perfectly true and out of wind, or free from twists on all surfaces, rectangular in shape and uniform in texture. They should also be free from holes or lumps



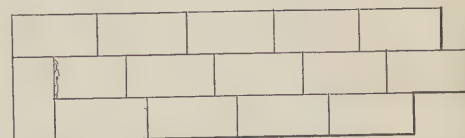
B



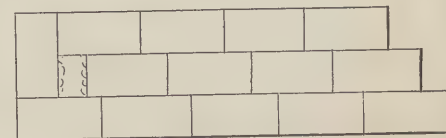
B



B



B



B



B

FIG. 44.

of stone, and be "well burnt"—which means they should not be black or over-burnt, but solid and like a sponge, and contain sufficient capillary attraction to absorb, when immersed not over $\frac{1}{4}$ their weight of water. A good brick dry weighs from $3\frac{1}{4}$ to $3\frac{3}{4}$ pounds; wet

for laying from 4 to 4¼. Four pounds is about the average weight in a pile sprinkled ready for laying. All "Lammies", bloated, misshaped, pale, soft and crumbled brick are unfit for use, and are only a detriment to a piece of brickwork.

Bricks can be tested by striking two together face to face, or when being dumped from the truck. If good, they will give out a sharp, clear sound.

brick, breaking joint every 4 inches. This thickness of brickwork is rarely or ever used for bearing purposes, but is adapted for "lining" stone or brick walls, and as it is then liable to buckle, if built too high, it should be keyed or anchored to the solid wall, which operation will be explained later. "Heading" courses are usually laid, every sixth course in walls of 8 inches in thickness or more, which are termed

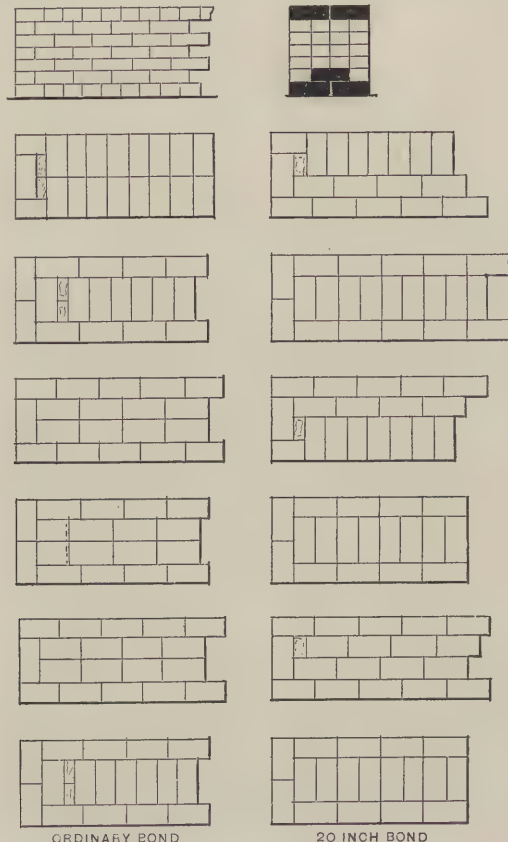


FIG. 45.

BONDING BRICK WALLS.

In bricklaying there are several bonds used in constructing rough or bearing walls, the "English" and "Flemish" being most popular, especially the former, which is almost the universal form followed.

Fig. 40 shows the elevation and end of a brick wall, one brick or 3½ inches thick, with a regular 4-inch or half brick bond of "stretchers," or whole

"bond" courses. At Fig. 41, I illustrate the side and end views of an 8-inch brick wall, showing how the wall is "bonded" by tying it together with a course of "headers" laid every sixth course. The wall is commenced with a course of headers and carried up thus, making a strong construction, each course being laid by the bricklayer, as shown at Fig. 42, one after the other as numbered. B represents the place

where the bricklayer stands, and the dotted line shows how he works from left to right in laying his brick.

A 12 inch brick wall with the bricks laid in proper bond is shown in elevation and section at Fig. 43, where it will be noticed the "heading course" are laid every sixth course, as in the 8-inch wall, with the difference that it is carried up on both sides of the wall.

Fig 44 will give a full explanation of the bonding courses as each is laid, the letter B representing, as before, the working position of the bricklayer, and Fig. 45 will explain the full operation of bricklaying used in the construction of a 16-inch wall. Here the elevation section and twelve courses are given,

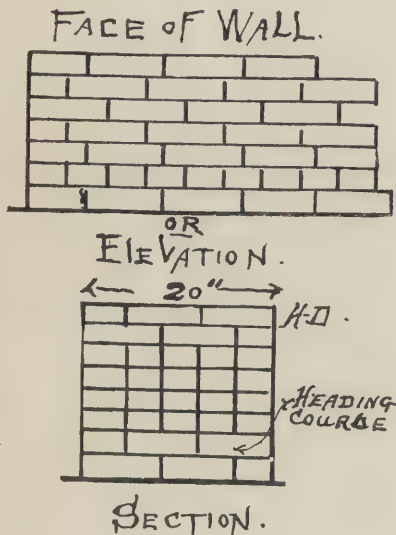


FIG. 46.—ELEVATION AND SECTION OF 20-IN. WALL.

the six on the left representing the ordinary bond and those on the right the 20-inch bond, which is sometimes used in good work.

Fig. 46 of the illustrations gives the elevation and section of a wall, two brick and a half, or 20 inches thick, which, with one inch of mortar added on, or approximately half an inch for each joint, would make the wall actually 21 inches thick. These two sketches give the heading and stretcher courses in the wall, showing their appearance when laid, and the six courses seen in Fig. 47 show the bricks as they are laid from the bottom up, course by

course, using brick "bats" or quarter and half sized pieces or half brick and three quarter brick in starting the first

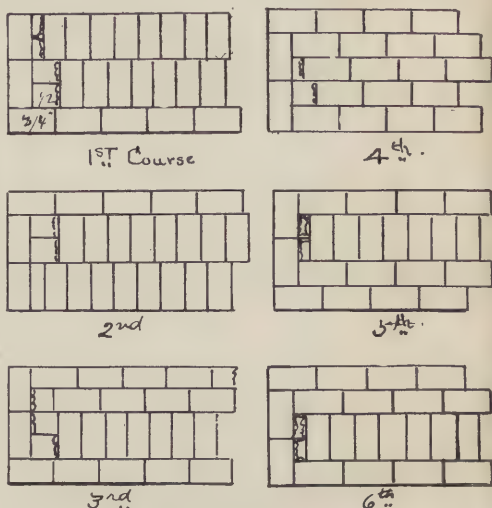


FIG. 47.—SIX COURSES; 20 IN STRAIGHT WALL.

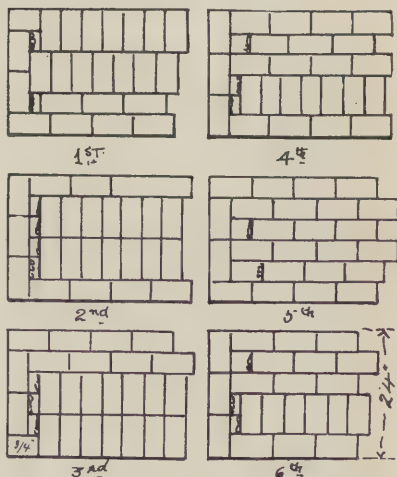
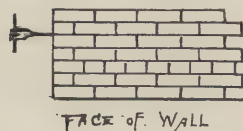


FIG. 48A.—24-IN. ORDINARY BOND.

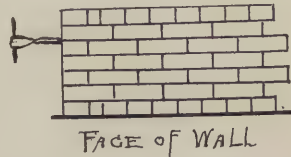
course and on the third course in order to give a two-inch bond and break joint.

The plans of six courses and face view of the 24-inch wall, represented at Fig. 48A, will convey to the reader how "bricklaying" entails more work and becomes more difficult as walls, piers, etc., increase in thickness in order to obtain thorough "bonding." This is done by laying the bricks in the positions delineated in the six courses where "closers" or "bats" and half brick are again used to distribute the joints and obtain full bonds in headers and stretchers.

A close study of the bonding diagrams is the best way to get a proper knowledge of the exact positions of the bricks, afterwards watching the work when in course of construction to verify their accuracy.

Fig. 48B is a second system of bonding used in some 24-inch walls.

carried across the full thickness of the wall every six courses will be clearly seen; also how the T anchors, which should be inserted about every thirteen courses, are built in the joints and allowed to project to give not less than eight inches of "holding" on the wall to be tied to the eight-inch wall. These anchors are indispensable and should never be omitted when one wall is carried up before that to be built to it. Fig. 50 shows how they are made of $\frac{3}{4}$ or $\frac{1}{2} \times 2$ wrought iron, and average



CHAPTER V.

BUILDING BRICK ANGLES, CORNERS AND INTERSECTING WALLS.

THE foregoing diagrams complete the bonds used in straight walls from 8 to 24 inches thick, so the methods of anchoring and bonding followed by bricklayers to form angles will now be described, commencing with the important means which they adopt to tie walls together at right angled corners when one wall or section of a wall is built before another, as, for example, when the side, rear or party walls are laid up in advance of front walls. This sometimes occurs when the stonework or front brick are delayed; on circular corners, or when for any reason it is required to carry one wall up before that to be built to it, and when it is not possible to properly bond it course by course. In this emergency bricklayers apply the method termed "blocking" and "heading" which gives an excellent tie if wrought iron T-anchors be introduced and built into the ends.

At Fig. 49 the actual construction of the end of an eight inch cellar brick partition or party wall is represented as having been built to hold a front or rear wall which crosses it at right angles. By observing the engraving closely the four-inch "blocking"

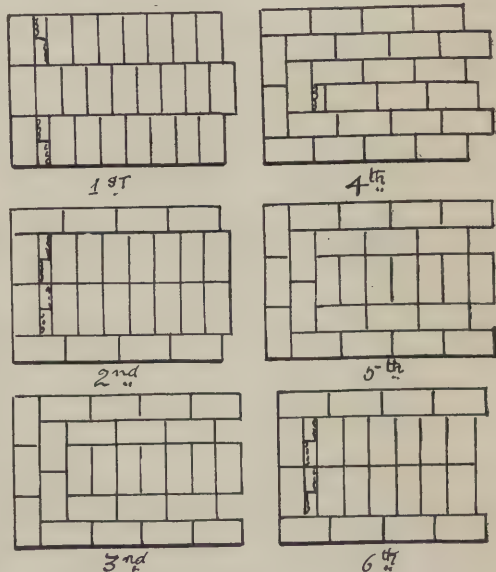


FIG. 48B.—24-IN. WALL, A 2D BOND.

from 16 to 36 inches in length. The reader will appreciate the application of this method of bonding and tying angles together with blocking and anchors by the perspective view of an eight-inch brick gable, Fig. 51, where a close straight vertical heading joint is necessary. Here the blocking of four inches occurs every alternate six courses, and the anchors are projected out to reach over eight inches in the front wall and give a strong holding. Fig. 52 will illustrate the end construc-

tion of a 12-in. brick wall built to sustain a front or rear wall, and Fig. 53 is an inside intermediate or party wall built for the same purpose. Similarly with Figs. 53 and 54 which are brick walls 16 inches thick.

In connection with these methods it might be stated here that the gable end blockings are reversed on the right or left hand ends, as they occur, to leave a straight, smooth wall on the outside, which will be understood from the foregoing engravings, as they are all drawn

left hand corner, but the same construction prevails for a right hand corner, and the reader will readily perceive its application by turning the book upside down. Because corners and angles constitute the main strength of every brick building they are invariably built with great care by the best bricklayers, who carry up six or more courses in height and "Rack out," like Fig. 56, for the straight wall. They also use great care in gauging the thickness of the mortar joints and keeping the apex

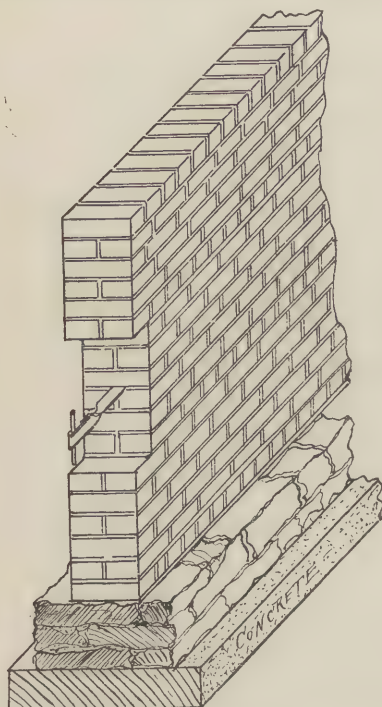


FIG. 49.—8-IN. INSIDE WALL, SHOWING HEADING FOR TYING INTO WALL AT RIGHT ANGLES.

from work during actual construction and are therefore accurate. However, many of the best bricklayers vary their work to suit the details and obtain the best results, so it is wisest to observe all the brickwork one can during its erection and note the different methods applied.

Bonding Angles and Intersecting Walls.

Fig. 55 shows six courses of bricks laid in the positions necessary to obtain the proper bonding and tying of a right angled corner or "lead" for an 8-inch wall. Here the bonds are given for a

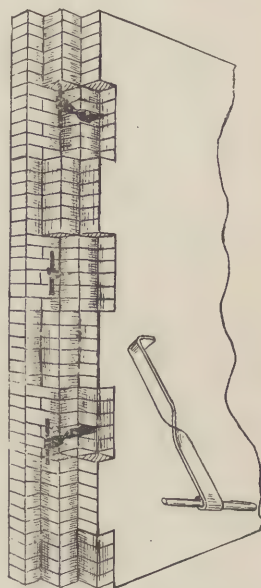


FIG. 50.—IRON TIE END.

FIG. 53.—FRONT END OF 12 IN. GABLE, OR SIDE WALL SHOWING HEADS FOR TYING IN FRONTS.

of each of the angles on the faces of the walls exactly plumb by a frequent application of the "Plumb Rule," Fig. 19. In fact corners and angles are the most important parts of walls, as from them lines are stretched to guide the courses straight and level, and consequently ensure a plumb and level construction. The diagrams of six courses, each represented in Figs. 57, 58, 59 and 60, give the construction of brick walls, 12, 16, 20 and 24 inches in thickness, and being self explanatory require no further description.

Concerning the methods of bonding; "Party" or intermediate walls occurring either transversely or longitudinally

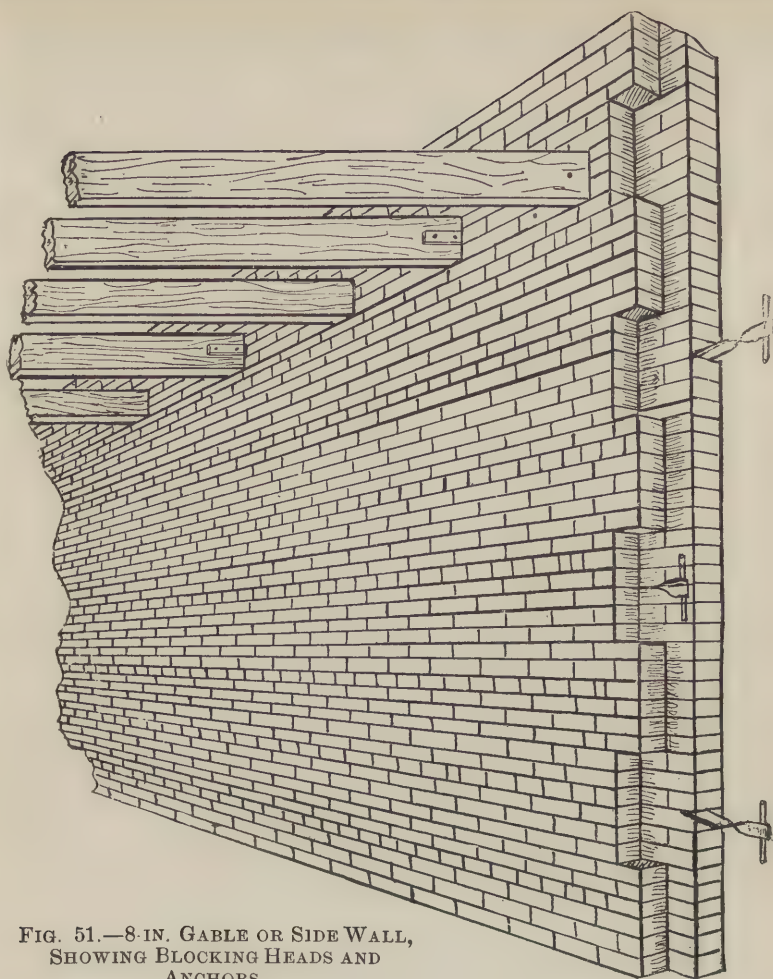


FIG. 51.—8-IN. GABLE OR SIDE WALL,
SHOWING BLOCKING HEADS AND
ANCHORS.

FIG. 53.—END OF 12-IN. PARTY OR
INSIDE WALL, SHOWING 8 IN. HEADING
AND ANCHORS.

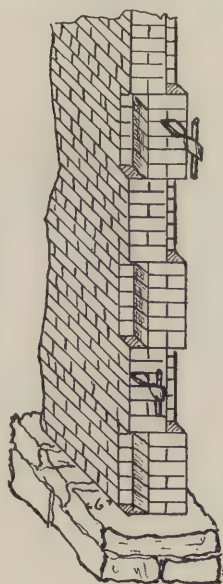
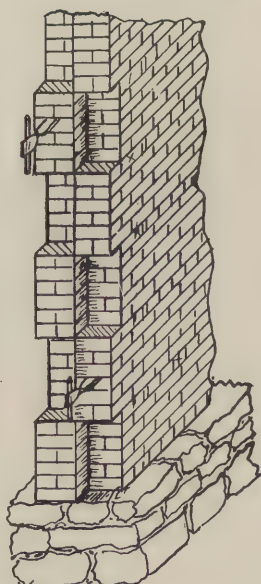


FIG. 54.—END OF 16-IN. PARTY OR
INTERMEDIATE WALL, SHOWING ALTER-
NATE 8 IN. BLOCKING.



ally, and cutting into front, rear or side walls the reader will see the bricklaying of these courses fully illustrated by the diagrams Figs. 61, 62, 63, 64 and 65, which show how the joints are scattered,

and explain here the application of the "Story Rod." An important essential to every bricklaying foreman engaged in building construction.

This "Rod" is simply a good stiff

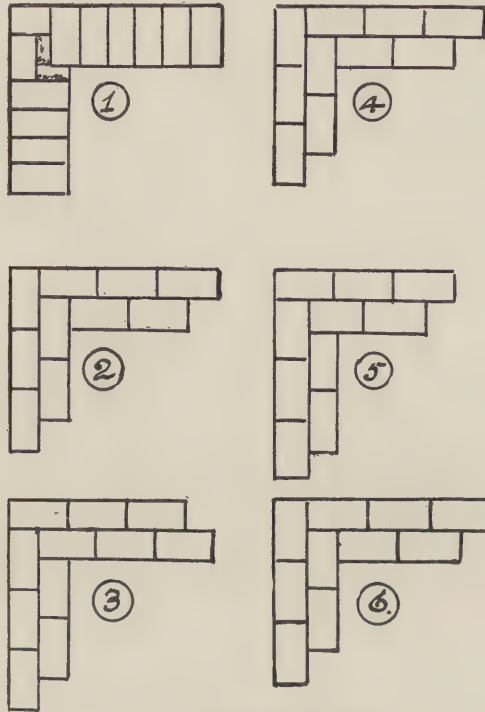


FIG. 55.—8-IN. CORNER.

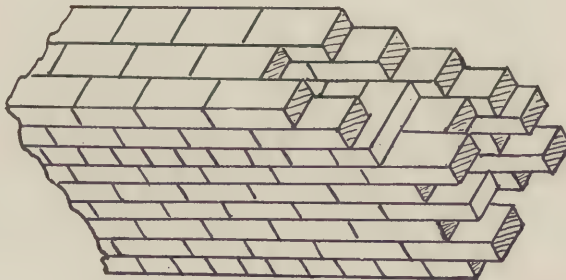


FIG. 56.

or "staggered," and the two walls thoroughly tied together course by course.

While commenting on the subject of corners and angles, from which the measurements of all walls are regulated and built, it is advisable to introduce

strip of wood made of a spruce $1\frac{1}{4}$ " x 2" furring strip or 2" x 2" stud, spaced out by thicknesses of brick and mortar joints to the height of each story. For example, if the first story be 10'-6" in the clear, finished, that is with the floors laid, and the plaster on the ceil-

ings, then the rod must be the full length in the clear of the floor beams, or from the top edges of the first story beams to the bottom edges of these second story beams above and be spaced out in the following manner: First, the rod is measured off and cut the exact height of the story, namely 10'-8", and then divided up for the courses, by finding the number required to be laid to reach this height. This can be done in several very simple ways: First, by taking $2\frac{1}{2}$ inches for each course and dividing the height in inches by $2\frac{1}{2}$ inches thus: 128

inches in thickness, but they are sometimes built thicker in engineering and building constructions, increasing by 4 inch or 8 inch thicknesses to the greatest desired. In building these walls the usual practice is to reproduce and duplicate the bondings shown in the preceding engravings, to suit the increased thickness, and by grouting in the courses to fill all possible voids, thus making a solid mass, if the grouting hardens in the interior of the wall. This is doubtful, especially when the

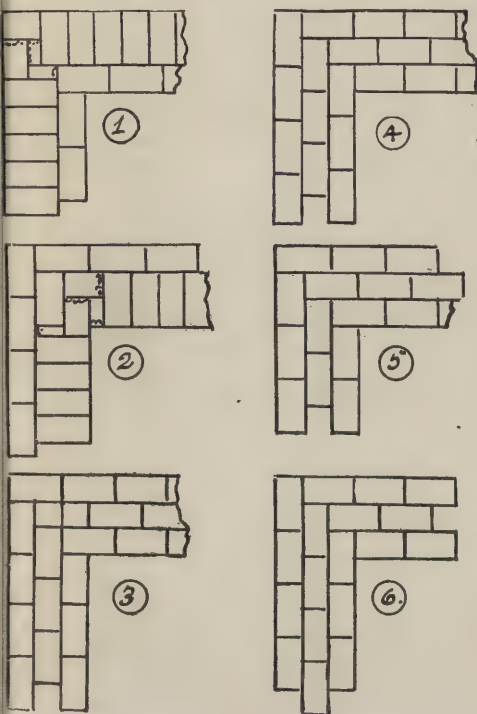


FIG. 57.—12-IN. R. A. CORNER.

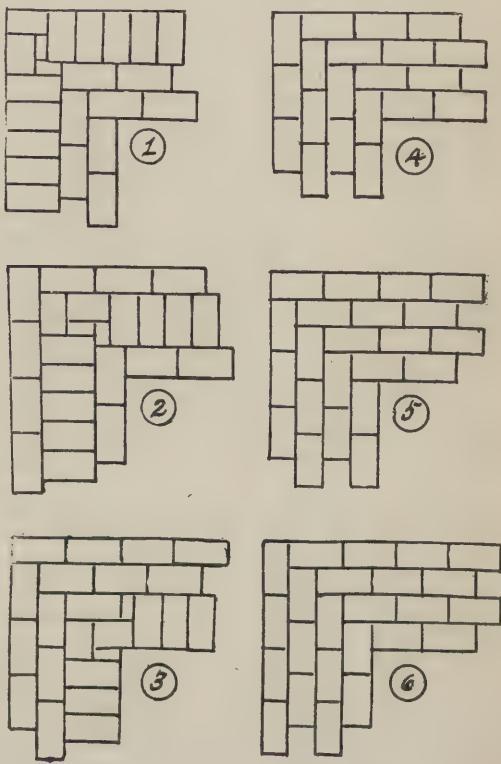


FIG. 58.—16-IN. R. A. CORNER.

inches divided by $2\frac{1}{2}=51$ —No. of courses required; or, again assume 5 courses to build $12\frac{1}{2}$ inches in height. Then $10'-8" \times 12"=128$ inches. For 51 brick courses $2"$ thick allow 102 inches. For $51\frac{1}{2}$ mortar joints allow $25\frac{1}{2}$ inches, which will make $127\frac{1}{2}$ inches, and allow $\frac{1}{2}$ inch for leveling up the beams.

The foregoing diagrams and engravings with their descriptions embrace brick walls increasing from 4 to 24

grout is made of Rosendale Cement, unless it is made up with a large proportion of cement thoroughly tempered and not too liquid, as borings and incisions made in very thick walls have revealed that in the interior the cement had not set after being built for months. The cement being inside is entirely protected from the direct hardening action of the atmosphere and consequently it sets very slowly.

Acute Angle Corners and Intersecting Walls.

We will now take up those walls, the plan of which is an acute or obtuse angle, and will commence with Fig. 66 which is the plan of one course of an acute angled corner. This sometimes occurs on the general house plan, on an inside lot, or Gore, as it is termed, by real estate men in many localities. In this engraving the wall is represented

work, but is not good bricklaying as the "pigeon holes" form receptacles for accumulation of water, snow, ice and frequently nests of birds, and the result is that the brickwork rapidly deteriorates. When possible, therefore, it is better to obtain molded brick for these angles. It must be remembered, however, that the above description refers only to ordinary rough brickwork, and not to front work, where pigeon holes are rarely introduced, as their artistic

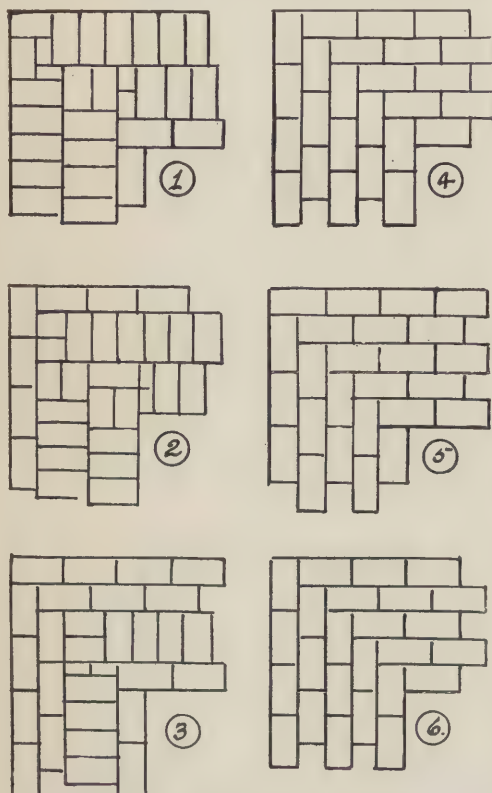


FIG. 59.—20-IN. R. A. CORNER.

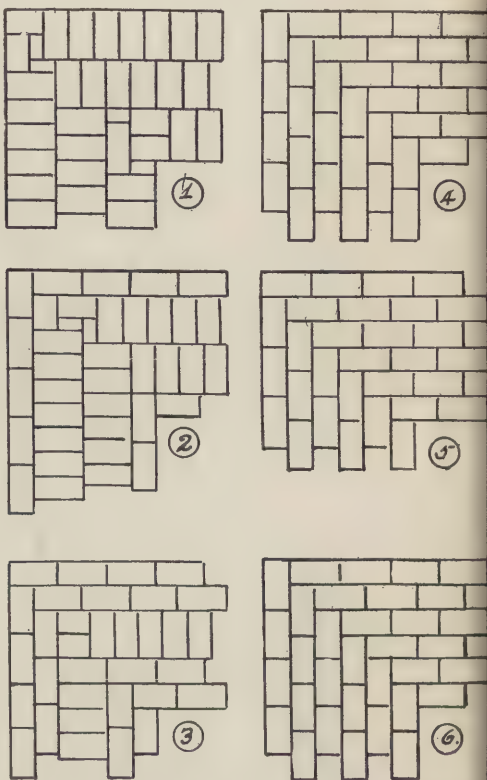


FIG. 60.—24-IN. R. A. CORNER—6 COURSES.

as built out almost to a point, or the extreme apex of the angle; and is "pigeon holed" or laid up with vacant spaces on the right and left faces of each elevation. These "pigeon holes" are unavoidably made necessary by laying the bricks with square ends, which is done to economize time and labor, instead of using bricks with ends molded to the angle, or cutting the bricks to the bevel necessary to fit. The foregoing method is often followed in the cheaper class of

effect is very doubtful, and not popular with architects. Fig. 67 will illustrate the construction of this form of corner when built with an 8 or 12-inch flat end. It is just as strong, saves brick, and lessens the number of pigeon holes, so that it is a good form to follow on an inside angle. In this diagram the heading courses are shown in a 12-inch wall as in the one preceding.

Fig. 68, X and Y, show the ordinary obtuse angled brick corner which is

much used in the construction of modern city tenements, dwellings and other buildings where a legally fixed percentage of light and air is required to all the rooms, especially, on inside lots, where, in tenements, this plan has been found to give the best results in obtaining light and air and economizing space. The plans of the courses and elevation in these engravings show the usual obtuse angled corner of $22\frac{1}{2}$ degrees, and give the bricklaying for same, which, with the bonds illustrated in Fig. 59, will give the entire construction, as here the bricks are cut to a

tain great strength and form the mainstay of the straight walls to be built to them, they should always be laid up and bonded, course by course, and properly racked out for each straight wall.

The practice of carrying up one straight wall before another which abuts against it at right angles is a deleterious one and should never be permitted, because two walls built separately are much weaker than when tied together at every course, and they will never settle equally as the one first built will come to its permanent bear-

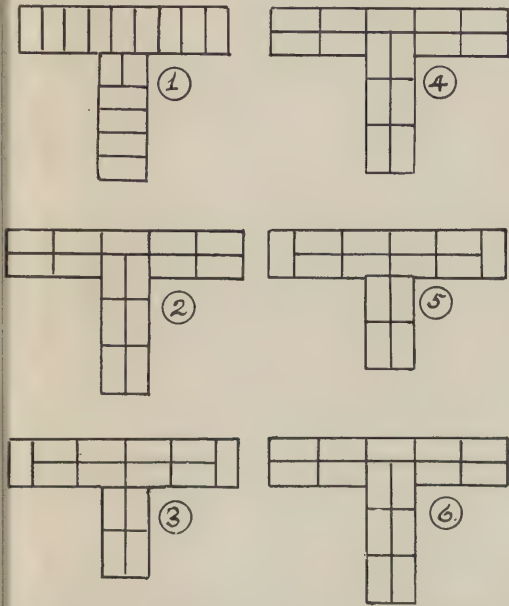


FIG. 61.—BONDING OF TWO 8-IN. WALLS.

close joint on the corner. A-B denotes the recurring and alternating on each course of the pigeon holes.

Concerning the bricklaying usually followed when building intersecting walls of various thicknesses, very little written description is required, as the bonds resemble very much those of the right angled corners, described in the straight wall description and the work will be fully understood by close and careful study. Fig. 70, 71, 72, 73, 74 give the bonding of 8-inch, 12-inch, 16-inch, 20-inch and 24-inch walls, which cross and intersect each other, so as to form four right angles. As these important walls when built con-

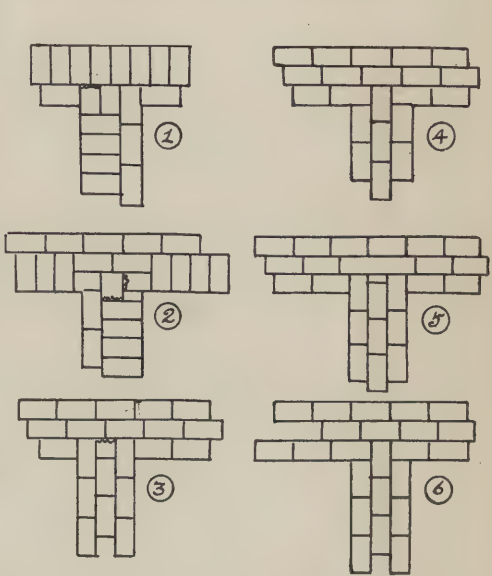


FIG. 62.—12-IN. WALLS.

ings before that built later; and the result is a permanent strain at the joint. To save time many good bricklayers resort to forming 4 or 8-inch pockets in the face of the straight wall and build in them heavy T-anchors thus giving an opportunity to lay up the straight wall more rapidly and economically from a line, than if carried up and bonded by courses.

The question of economizing time and working to advantage is a serious matter with contracting bricklayers, as many details have to be considered; notably, those of changing and moving scaffolding and preparing, conveying, and accumulating tools and material on

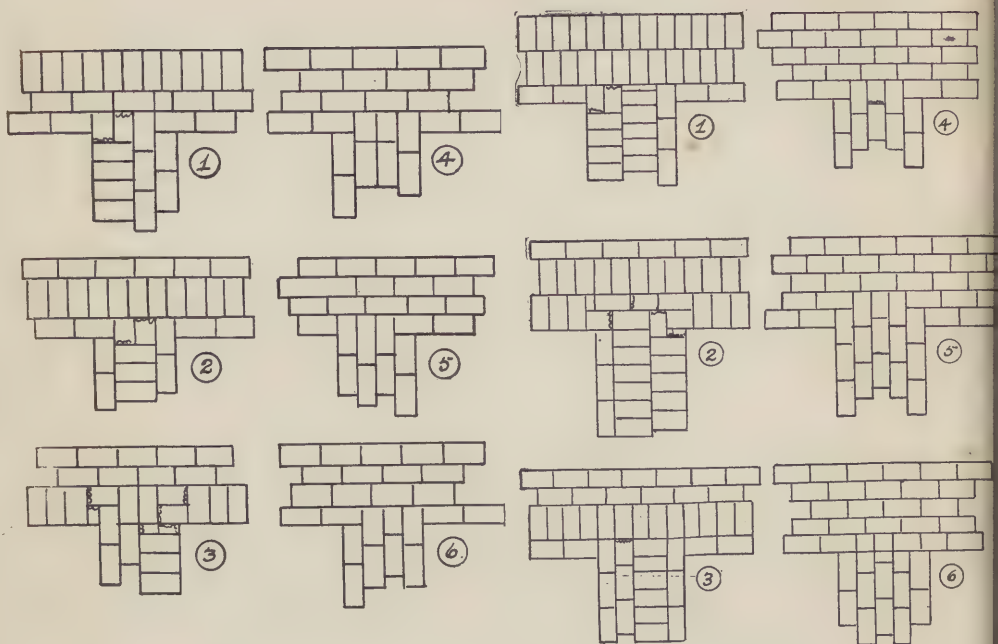


FIG. 63—16 IN. WALLS.

FIG. 64.

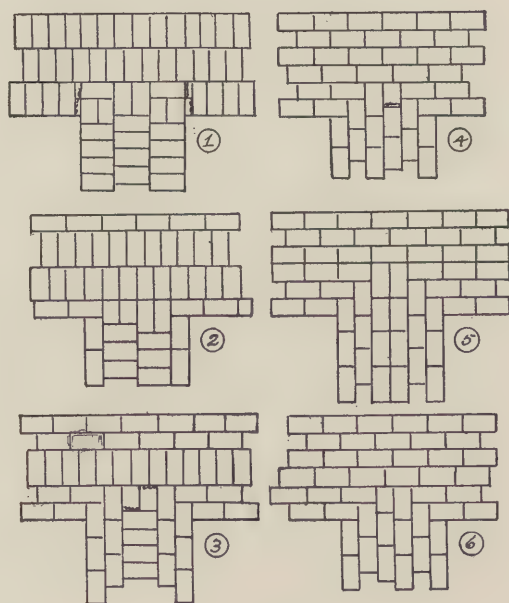


FIG. 65.

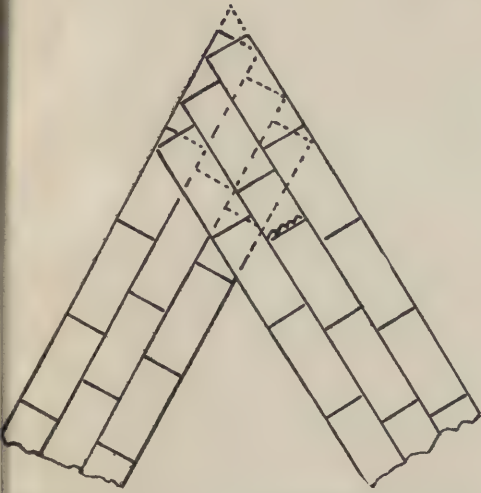


FIG. 63.—A 12-IN. ACUTE ANGLED CORNER.

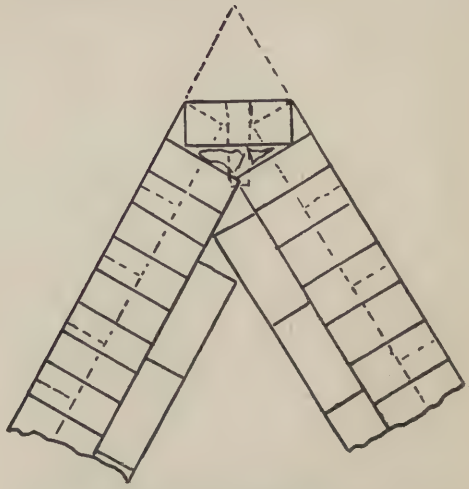


FIG. 67.—HEADING COURSE 12-IN. WALL, ACUTE ANGLED CORNER.

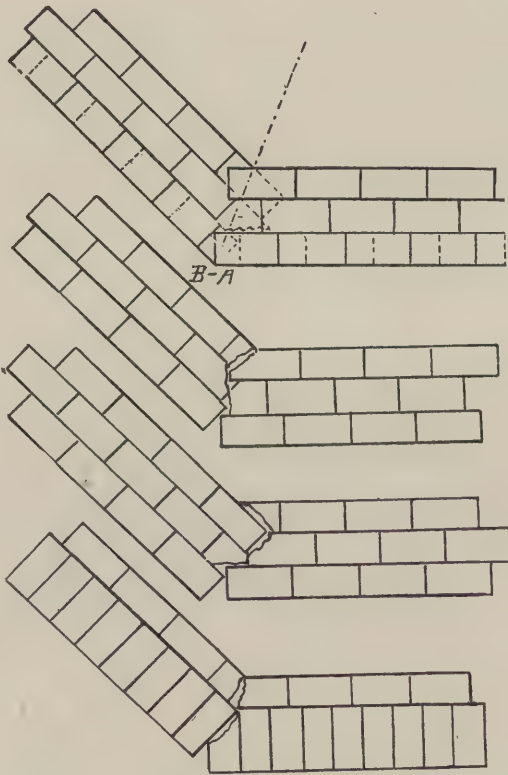


FIG. 68-Y.—OBTUSE OR OBLIQUE BRICK ANGLE, OUTSIDE CORNER WITH PIGEON-HOLE.

the scaffolds when ready to be worked on. For this reason foremen adopt and follow methods which will avoid as

voids formed by pockets, which are usually left every alternate 6 courses in height, weaken a straight wall, and it

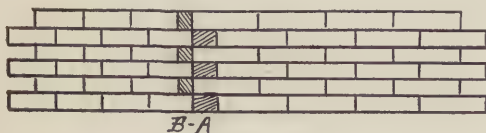


FIG. 68-X.

much as possible shifting scaffolds, and construct their walls, so their men will be kept continuously at work, by substituting for one method, another, which, though not as reliable, is still

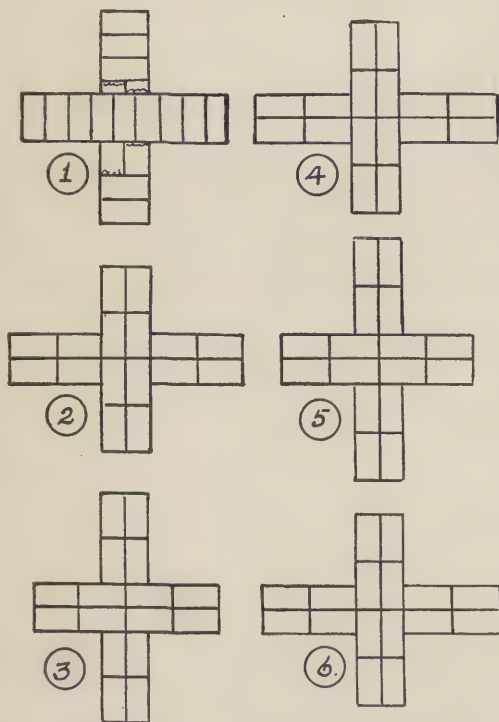


FIG. 70.—8-IN. INTERSECTING WALLS.

sufficiently good to be safe building. The introduction of "Pockets," "Blocking," and anchors in laying up cross-walls and intersecting walls instead of laying by courses may be cited as an example of varying construction which is of common occurrence in ordinary houses, and though not defective, it is nevertheless not good brickwork. The

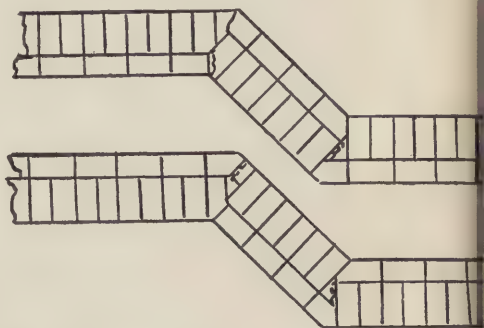


FIG. 69.—INSIDE AND OUTSIDE OBLIQUE OBTUSE BRICK CORNERS.

remains weak until the projected blocking on the one occurring at right angles is built to it. Many bricklayers project

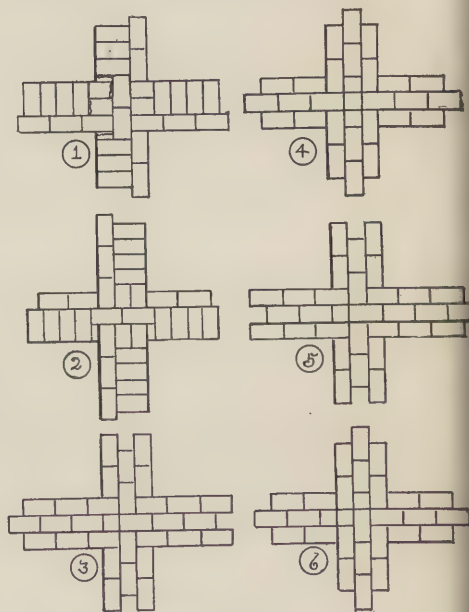


FIG. 71.

a blocking 4 inches from the surfaces of the straight walls to fit into the ends of these abutting, in order to obviate this

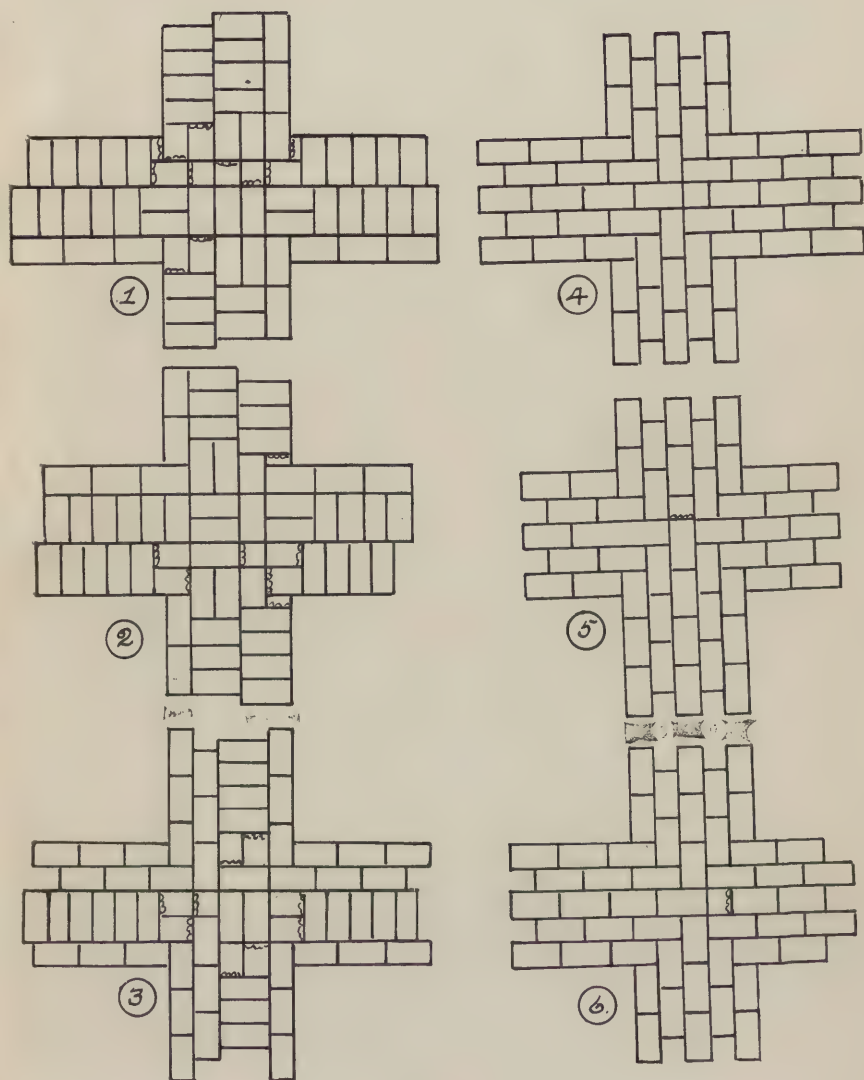


FIG. 78.

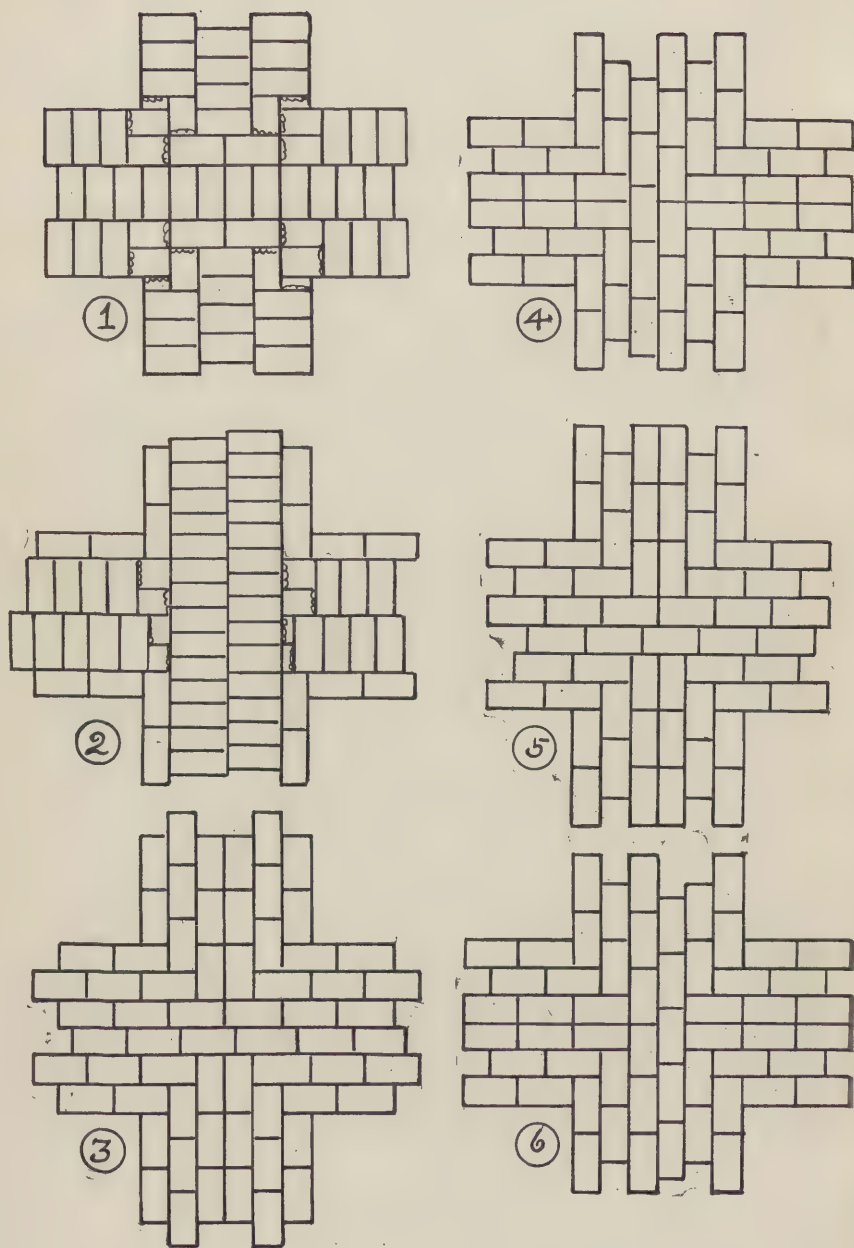


FIG. 74.

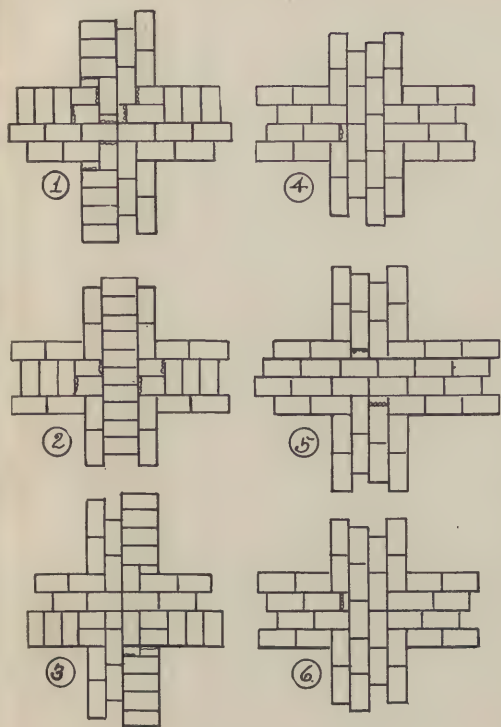


FIG. 72. (See page 33.)

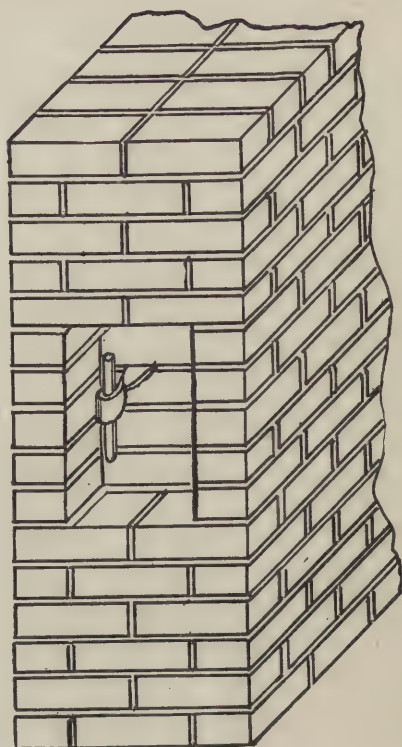


FIG. 75.

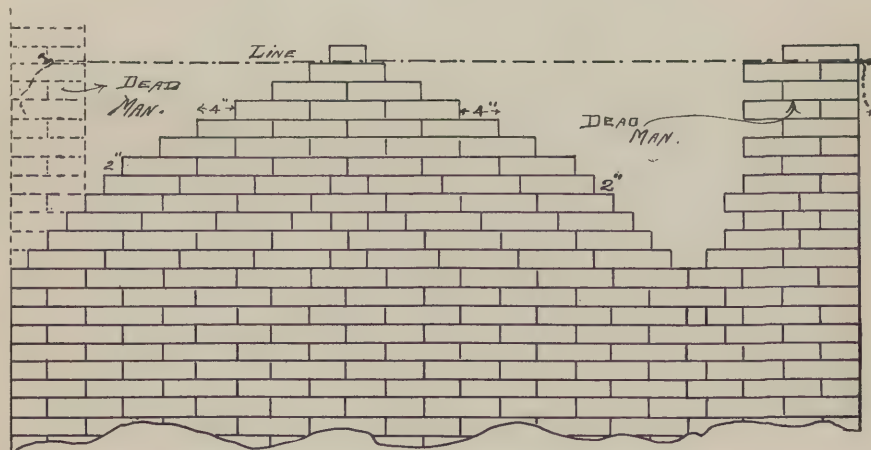


FIG. 75 A.

weakness, but it is never satisfactory in a constructive sense, so that in good work every course for all four angles should be fully bonded and racked out for the straight walls as they occur on the plans.

Fig. 75 represents an 8 by 12 inch recess pocket or chase, for obtaining a tie by blocking out from another wall which is to be built afterwards. These are formed of different regular sizes, according to the widths, lengths and thicknesses of the bricks, and according to the thickness of the wall, and have the anchors built in as represented in the engraving. They occur about every six courses in height, but are only an expedient to avoid laying course by course.

Fig. 75A shows the application of the "DEAD MAN" or temporary pier built by bricklayers for the purpose of carrying up the lines necessary when laying

climates, because the sun's rays acting daily and continuously on one or two sides, keeping them warm, and the opposite sides being cold, the masonry will bend towards the heat, so that the mortar should have great cohesive power.

CHAPTER VI.

LAYING BRICK IN FLEMISH, "RUNNING," AND "HERRING BONE" BONDS.

"FRONTWORK."

FLEMISH BOND.

CONSIDERING now the laying of brick in Flemish bond, which differs from English bond, previously described, in being less valuable in its constructive features and consequently much less applied and followed

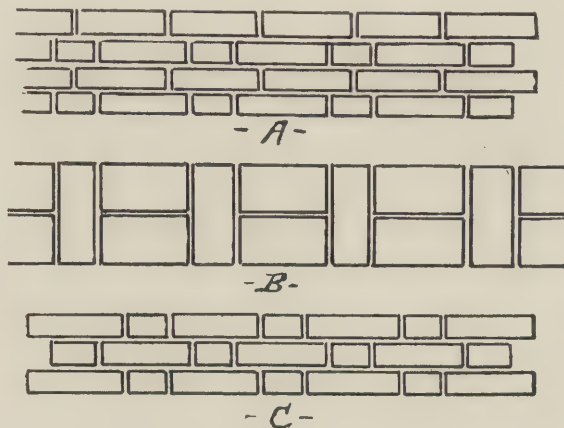


FIG. 76.

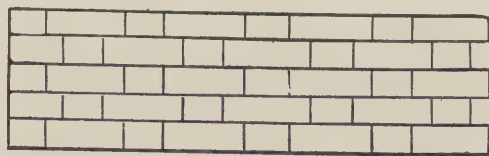


FIG. 77.

up a brick gable or any wall which steps or reaches back; the object of the "DEAD MAN" being to regulate the proper heights and levels of the courses. The application of this expedient is fully illustrated in the engraving.

Brick chimneys and parapet walls above the roof line should invariably be aid up in cement, especially in extreme

by architects and builders, we will commence by illustrating an 8-inch brick wall built in this bond.

Fig. 76 B shows one course with two elevations, A and C. It will be seen here that the bricks are laid "headers" and "stretchers" one after the other for the full length of the course. The second course, as at A, is laid entirely a

"stretcher" course so that the wall having too many longitudinal and transverse joints, is too expensive for a bearing wall. For ornamental purposes, as a fence wall, garden wall, or where expense is not considered, this form might be followed. The elevation C makes a handsome wall, but for structural purposes it also is valueless and expensive and consequently seldom employed in building construction.

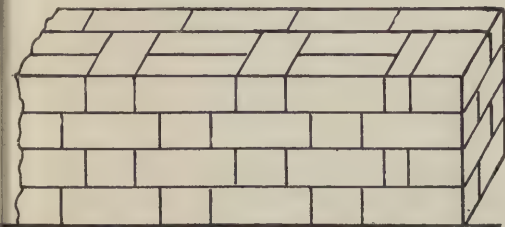


FIG. 78.

The 12-inch wall laid in this bond, which is explained by the two courses and the elevation and projection of correct and incorrect bonds, Figs. 77 and 78, have the same fault—namely, too many longitudinal joints or too few headers, in proportion to the material and labor expended.

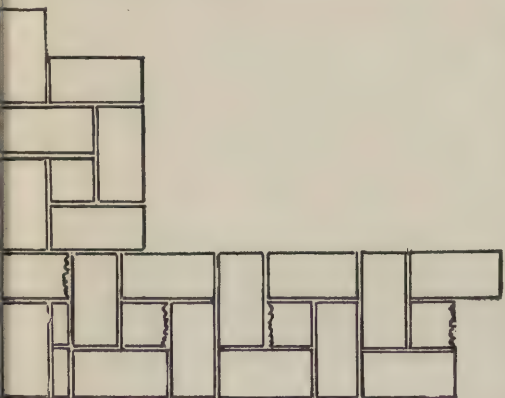


FIG. 79.

Fig. 79 represents the construction of the corner of a 12-inch wall laid up in double Flemish bond, showing the headers and stretchers on both faces of the wall, which makes it adaptable for work which is to remain uncovered, for face work, ornamental work, or any description of brick work where expense of time or workmanship are not considered. It is usual in thick constructive

work of this kind to back up with English bond, in which case the headers should be broken every alternate course. Fig. 80 gives two more courses of this

1ST COURSE2ND COURSE.

FIG. 80.

bond and illustrates how half bricks are inserted for dummy headers, which necessarily involves an expenditure of much time and labor in getting Bats to



FIG. 81.

suit, compels more longitudinal joints and consequently makes a weaker wall. A comparison of this engraving and Fig. 79 will show the superiority of the former, which is the best to follow should Flemish bond be specified or desired, as it gives a fuller bond, saves cutting, and makes a stronger wall.

The application of Flemish bond to 16-inch walls will be comprehended by referring to Fig. 81, the plan of one course, as laid. This, too, is open to serious criticism on account of the lack of absolute bond and longitudinal joints, so it is rarely specified by architects or carried out by mason builders. The writer has seen some samples of Flemish bond introduced in front work, where rock-faced bricks of standard

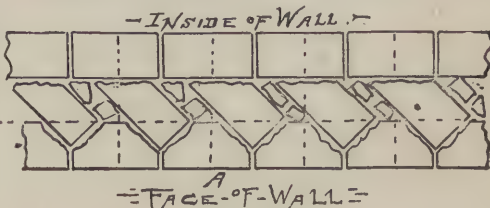


FIG. 82.

sizes were laid up in Flemish bond and backed up with rough bricks of the same size. This job was very effective in fronts of Colonial design, but the

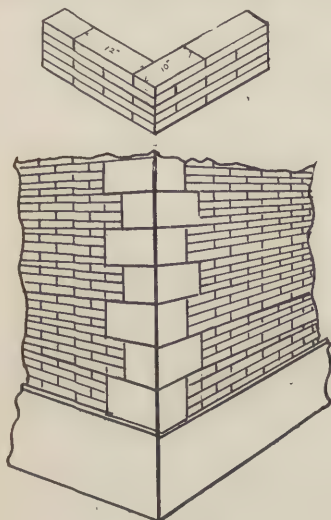


FIG. 83.

walls were non-bearing and well anchored back to the floor beams. All bonds in walls and piers laid up in Flemish bond should be thoroughly bonded in every course.

* * * * *

RUNNING BOND.

As we will presume the reader is now familiar with the construction of the bonds followed in rough work, we will now take up the subject of front brick work, where bricks of superior finish, quality and size are introduced for the purpose of producing an architectural or artistic effect. For example, in the outside surface or surfaces of walls forming the elevations or for inside and outside court, light shaft, kitchen, or other walls. In this work the bricks are laid entirely on stretcher courses, or what is termed "Running Bond," to get the best surface.

The construction of this bond is comparatively simple, as five of the stretcher courses are usually laid as in English bond, with the sixth course "clipped" or the corners of the bricks cut off with a trowel or hammer and chisel in the way seen at Fig. 82, which is the view of a course of "Clips," as they are called, laid in a 12-inch wall. The

bricks laid diagonally back of the clipped course are laid thus to obtain a diagonal or mitre bond, by the pressure downward of the next course which will be laid. This will be understood by referring to the dotted lines on the engraving, as they denote the joint lines of the next course recurring. The above method is applicable to both Ro-



FIG. 84.

man brick of standard size or those of the same size as common brick, which space out to suit the clips. The difference is that the Roman brick must be spaced out to suit the rough brick backing. If the wall is a bearing wall greater care is required in its construction. Fig. 83 is the perspective of a brick corner with Terra Cotta Quoins laid with running bond.

The use of clip courses has, however, now been obviated and partially superseded by the placing on the market of the square bricks suitable for bonding Flemish or running bond. Fig. 84, where this brick, popularly called American, or Chicago bond, is shown, as laid in the course. These bricks give a splendid tie back into the rough brick backing, but they are unhandy to lay and as a result there are many cities where they are rarely used.

Oftentimes architects, for the purpose of varying or suiting designs, specify front brickwork laid up in regular English bond, in which case, if brick of Roman sizes are to be laid, it will be necessary to space up the front bricks to header bond every sixth course into the backing. This can always be most accurately done by building a small sample on a little platform, to determine just how many courses of front work it will be required to build to get the heading course to bond with the six courses of backing.

Before Calabar, Gold, Mottled, Pompeian, or other front bricks of the darker colors are laid, each brick should be carefully turned over and examined to determine first if it be dry, and then, which is the fair, clean front edge. as the reverse edge is generally streaked with black marks from the kiln at right

angles to the faces, and these make an unsightly job and mar the general appearance of the front. If perchance any should get in, either wet or marred, they should, when discovered, be cut out and replaced. Each front brick being laid should first be dipped in water and then buttered on the bottom face at each edge and down the middle with mortar. When they are laid on the wall each brick should be carefully shoved to its place, or up to the one preceding in the course, and then gently rubbed down and tapped till the joint is the exact thickness required. Extreme care, time and skill is required to do this work correctly and thoroughly in order to keep all vertical joints on a plumb line, all horizontal joints gauged true and level and of the same thickness, and all the front edges of the bricks on the face of the wall fair, plumb and true.

Returns of "face brickwork" must be always carefully bonded and tied into the backing by solid headers or iron anchors.

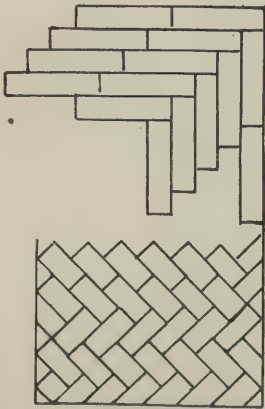


FIG. 85—HERRING BONING.

In front or face brickwork the joints should never exceed 3-16 of an inch, except where regular sizes in Flemish bond are used, in which case $\frac{1}{4}$ of an inch would not be irregular. Front brick usually measure 25 inches to 10 courses. Common brick 24 inches to 9 courses. So face bricks must be properly spaced out to thoroughly bond, and all iron anchors, which are frequently inserted with glazed, colored or enamel bricks with hollow faces, beds or sides, or sometimes with Roman bricks, will require to be built in on each course.

If the front work be backed up with

Lafarge, Puzzalona or lime mortar to prevent the black liquid in the backing, when laid in Rosendale cement mortar from working through to the face of the work, this will require to be done, as each series of front courses is laid, care being taken not to jar or disturb the front work. The rough backing may then be laid, or the front "backed up," as it is technically termed.

Fig. 85 gives two designs of "herring bone" bond, or "herring boning," as many bricklayers term it. This is not properly a bond and scarcely deserves the name, but it is often introduced in fronts and gives an excellent effect when artistically introduced in the design. It is most applicable in panels in interiors, wainscots, soffit of arches, etc., or any place where the brick used are colored or glazed or enameled.

The brickwork shown in projection at the top of Fig. 86 represents a good piece of modern front work when laid, showing inside and outside angles with different bonds, and here the reader will recognize for the first time the importance of the workmanship required to make a first-class job. Laying front bricks as they are manufactured at the beginning of the 20th century is an art, and requires a large expenditure of time and much manual skill on the part of bricklayers in order that the work may be laid up in its details, to be as near perfection as possible. That the mechanical skill of the bricklayer has advanced and kept pace with the improvement in bricks and terra cotta can be seen in the beautiful elevations of buildings which have been erected in our cities within the last 25 years. Reference to the engravings, Figs. 87, 88 and 89, will show the great care and calculation which the bricklayer must exercise in working out the complex details of front brickwork, designed by modern architects, as they illustrate a few of the many different details of front brick which from their multifarious and ever-varying nature tax the ingenuity of the mechanic heavily in laying and obtaining a perfect job. An eminent architect, at present practising in New York, once stated in the presence of the writer that "he who would be great in his profession must have the greatest knowledge of its details;" so that these engravings are submitted with a view to show the reader how great an amount of detail there is in constructive and architectural brickwork, and guide him in superintending.

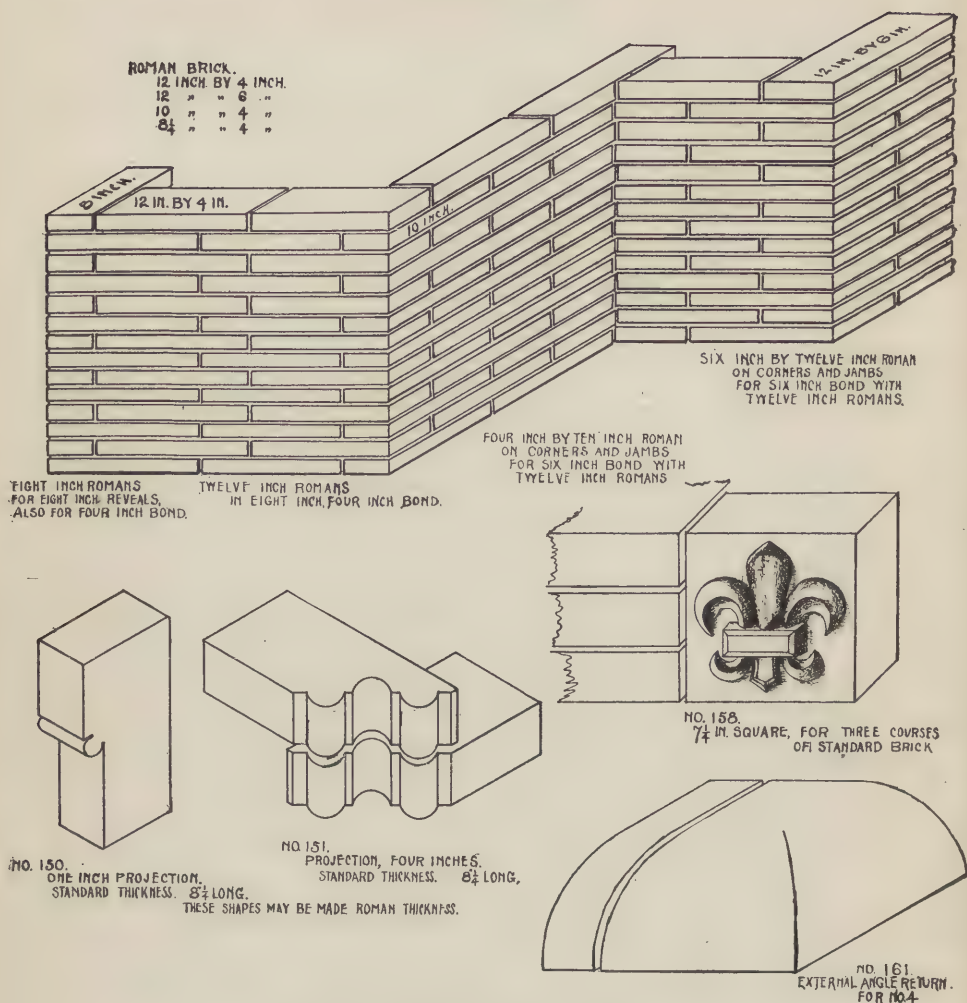


FIG. 86—FRONT WORK AND DETAILS.

Large surfaces of front brickwork, if improperly or carelessly laid, show "hacks," or little shadows and comparatively rugged surfaces when under the rays of strong sunlight, which accentuate all the faults and defects developed in the laying, and render them distinctly visible to the naked eye, but unfortunately the sun does not enter into the matter until after all the scaffolding is removed and the front "washed down," so that it is difficult to get an entire view. The work should be done right at first, and be free from imperfections which will surely render the building unsightly.

Regarding the matter of "pointing and washing down." This is usually done when the fronts are topped out and the cornices set and backed up. After pointing each and every vertical and horizontal mortar joint, the washing down should begin at the top and be done with brushes dipped in a liquid solution composed of one part muriatic acid and four parts of water, thoroughly mixed till its taste resembles that of lemonade. As the front is washed down and all patching and regulating done, the scaffolding is taken down and the job is completed. Some owners, for the purpose of preserving the work from

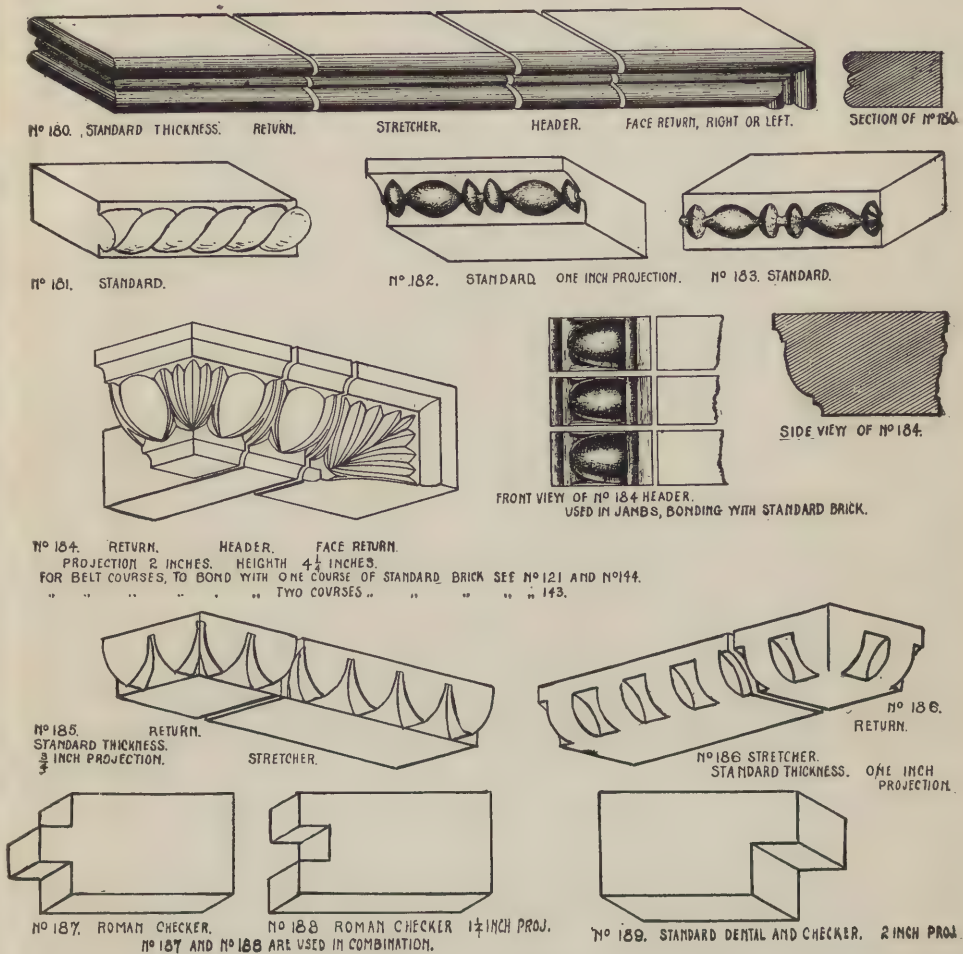


FIG. 87—DETAILS OF FRONT WORK.

weather stains and other possible injuries, have their front brickwork rubbed down or coated with one or two coats of pure raw linseed oil, but this afterwards can be done from a swinging scaffold.

As much of the artistic success of front bricklaying depends upon the proper selection and blending of the colors of bricks and front mortars, only great care, past experience, or the building of a small sample of the proposed work should determine what is suitable. Small samples of a dozen brick or more may be built to select those most desir-

able, the mortars being mixed according to the following rules:

DIRECTIONS FOR MIXING MORTAR COLORS.

First mix the color with the dry sand, then add the cold slacked lime, and again mix thoroughly. It is very important that the color be uniformly mixed. If it is not added at first, but left until the mortar is made, the labor of mixing is doubled. The more thorough the mixture, the less color is required, and the cheaper it is for the consumer.

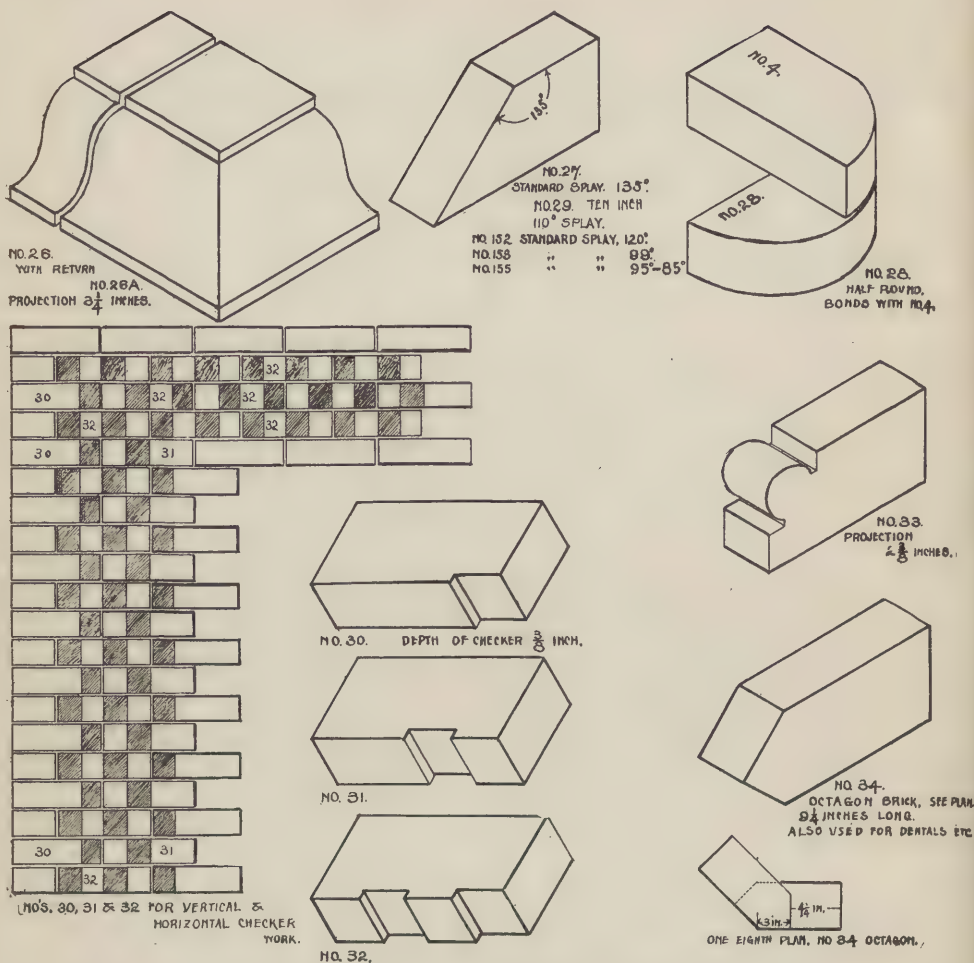


FIG. 88.—FRONT BRICK DETAILS.

DIRECTIONS FOR USING MORTAR COLORS.

Red, Brown and Buff.

For laying 1,000 brick with spread joints, use about 50 pounds of color to two and one-half bushels of lime and one-half yard of sand. For buttered joints use 45 pounds of color.

Black.

For laying 1,000 brick with spread joints, use from 40 to 45 pounds of black color to two and one-half bushels of lime and one-half yard of sand. For buttered joints use from 25 to 35 pounds color.

For Mottled Work.

Mix each color in a separate portion of the mortar or plaster, then produce the mottled effect by combining the different colored mortars.

The following is the approximate weight of mortar colors, Sterling brand, in each barrel:

Red in bbls., 400 to 450 lbs. (dry).
Buff and brown, 400 to 450 lbs. (dry).
Black, 400 to 800 lbs. (dry).

* * * * *

SIZES OF FRONT BRICKS.

There is some difference in size between bricks of the lighter and the

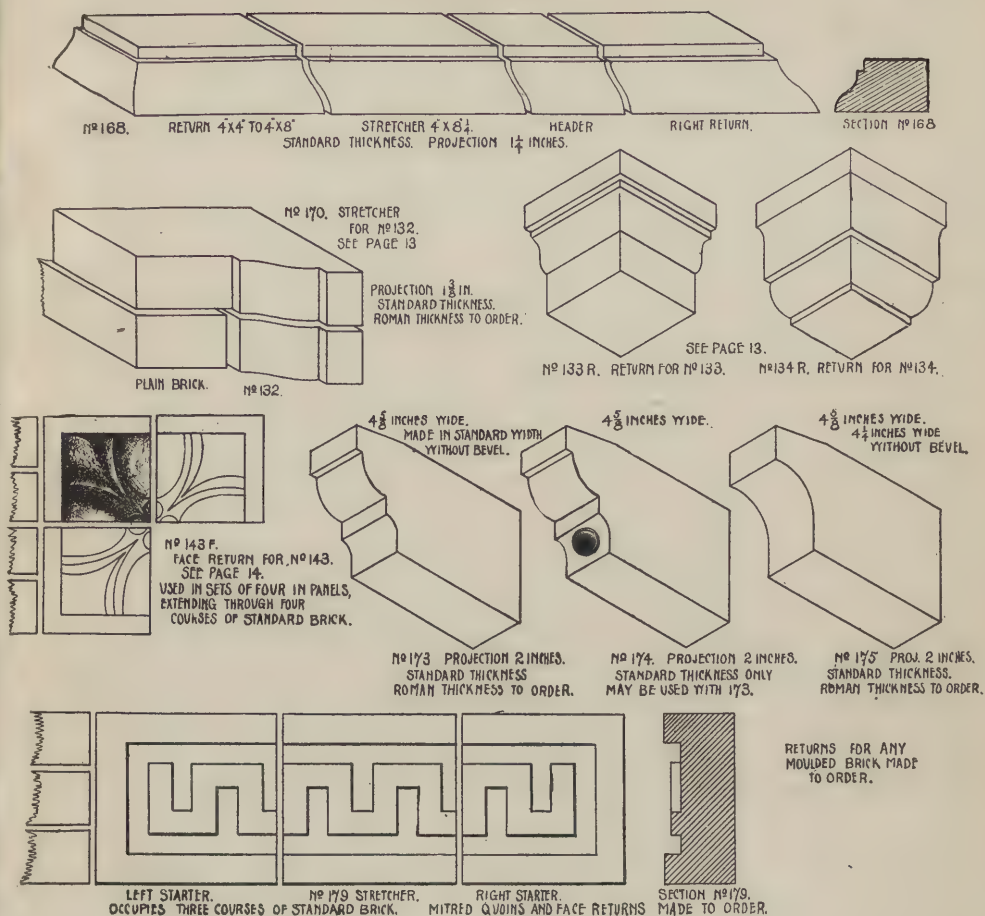


FIG. 89.—SOME MOLDED FRONT BRICKS.

darker shades—however, all bricks of any oneshade are uniform in size. The following is approximate:

Approximate size
in inches.

Standard size, Red..... $8\frac{1}{8} \times 2\frac{3}{8} \times 4$
Standard size, other
colors..... $8\frac{1}{4} \times 2\frac{1}{4} \times 4\frac{1}{8}$
Roman size, Red..... $11\frac{3}{4} \times 1\frac{11}{16} \times 4$
Roman size, other colors..... $11\frac{3}{8} \times 1\frac{1}{8} \times 4$

Molded shapes are standard size, unless otherwise specified.

Molded shapes shown as standard size can usually be made to order of Roman thickness and standard length.

Impervious White or Grey Face.

Approximate size
in inches.

Standard size..... $8\frac{1}{8} \times 2\frac{1}{4} \times 4$
Roman size..... $11\frac{3}{8} \times 1\frac{1}{8} \times 4$

Enameled Bricks.

Approximate size.

Enameled surfaces.

American size stretcher..... $8\frac{1}{8} \times 2\frac{1}{4} \times 4$ $8\frac{1}{8} \times 2\frac{1}{4}$
American size header..... $8\frac{1}{8} \times 2\frac{1}{4} \times 4$ $4 \times 2\frac{1}{4}$
American size *quoin..... $8\frac{1}{8} \times 2\frac{1}{4} \times 4$ $8\frac{1}{8} \times 2\frac{1}{4}$ and $4 \times 2\frac{1}{4}$
American size return..... $8\frac{1}{8} \times 2\frac{1}{4} \times 4$ $8\frac{1}{8} \times 2\frac{1}{4}$ and $2\frac{1}{4} \times 4$ and $2\frac{1}{4} \times 4$

	Approximate size.	Enameled surfaces.
Roman size stretcher.....	$11\frac{1}{8} \times 1\frac{1}{8} \times 4$	$11\frac{1}{8} \times 1\frac{1}{8}$
Roman size header.....	$11\frac{1}{8} \times 1\frac{1}{8} \times 4$	$4 \times 1\frac{1}{8}$
Roman size *quoin.....	$11\frac{1}{8} \times 1\frac{1}{8} \times 4$	$11\frac{1}{8} \times 1\frac{1}{8}$ and $4 \times 1\frac{1}{8}$
Roman size return.....	$11\frac{1}{8} \times 1\frac{1}{8} \times 4$	$11\frac{1}{8} \times 1\frac{1}{8}$ and $4 \times 1\frac{1}{8}$ and $4 \times 1\frac{1}{8}$
Roman Tile Enameled on flat...	$11\frac{1}{8} \times 1\frac{1}{8} \times 4$	$11\frac{1}{8} \times 4$
Roman Tile Enameled on flat quoin....	$11\frac{1}{8} \times 1\frac{1}{8} \times 4$	$11\frac{1}{8} \times 4$ and $4 \times 1\frac{1}{8}$
English size stretcher.....	$9 \times 3 \times 4\frac{1}{2}$	9×3
English size header.....	$9 \times 3 \times 4\frac{1}{2}$	$4\frac{1}{2} \times 3$
English size *quoin.....	$9 \times 3 \times 4\frac{1}{2}$	9×3 and $4\frac{1}{2} \times 3$
English size return.....	$9 \times 3 \times 4\frac{1}{2}$	9×3 and $4\frac{1}{2} \times 3$ and $4\frac{1}{2} \times 3$
English size Enameled on flat...	$9 \times 3 \times 4\frac{1}{2}$	$9 \times 4\frac{1}{2}$
English size Enameled on flat *quoin.....	$9 \times 3 \times 4\frac{1}{2}$	$9 \times 4\frac{1}{2}$ and $4\frac{1}{2} \times 3$
Soap brick, American size.....	$8\frac{1}{2} \times 2\frac{1}{4} \times 2\frac{3}{8}$	$8\frac{1}{2} \times 2\frac{1}{4}$

* These quoins are made with either square or round corners.

Enameled Bricks of superior quality are manufactured in the following sizes. They may be obtained enameled on three sides if desired:

English size, sq. corners.	$9 \times 3 \times 4\frac{1}{2}$
English size, round corners.....	$9 \times 3 \times 4\frac{1}{2}$
Roman size, round and square corners.....	$11\frac{1}{8} \times 1\frac{1}{8} \times 4$
Amer. size, round and square corners.....	$8\frac{1}{8} \times 2\frac{1}{4} \times 4$
American soap, square corners.....	$8\frac{1}{8} \times 2\frac{1}{4} \times 2\frac{3}{8}$

Glazed Bricks.

These bricks having a transparent glaze on the surface of a white pink, buff or grey color, produce beautiful effects, and the glazed surface being impervious to moisture give a brick of high value from the standpoint of cleanliness and hygiene. They may be obtained same shapes and sizes as enameled bricks.

COLORS.

Buff, grey, gold, mottled, and Pompeian bricks are not assorted to shade closely as is customary with red bricks.

This variety, in harmonious shades, adds to the beauty of a building.

CHAPTER VII.

BRICK ARCHES, LINTELS AND PIERS. PARAPET AND HOLLOW WALLS.

OPENINGS in brick walls are spanned in two ways; by solid stone, wood or iron lintels and girders, or by brick or stone arches of different forms. So the subject of brick arches will now be taken up by first illustrating, at Fig. 90-A, a

simple stone lintel 4 inches thick, 3 courses of brick high and having 4 or 5 inches of bearing.

The forms of brick arches generally used in buildings are named the flat arch or the camber arch, the segment arch, the semicircular arch, the elliptic arch, and the Gothic arch. These may all be built of brick, so we will commence with simple segment arch over window frames, door frames, etc.

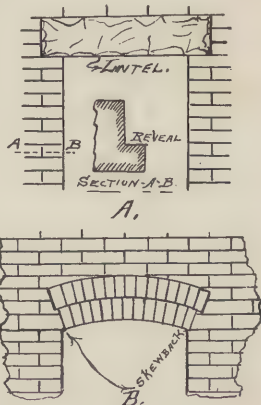


FIG. 90 A-P.

The construction of this arch is comparatively simple, as the bricks are laid face to face with the bottom edge resting on the "centre," a wooden framework set temporarily below to carry it. The bricks are laid, from the skewbacks at the line of window or door jambs to the centre or crown of the arch, each brick being thoroughly bedded in mortar face to face and laid true on the face and edge. When the centre or crown is reached the arch or "row-lock" of brick is there wedged tight,

by fitting a tapered piece of brick to form a key. Should a second "rowlock" be required it is laid as just described. This foregoing operation is explained by Fig. 90-B, where two rowlocks of brick are shown turned over a window opening. These arches should never be turned with brick set on end as the joints are too wide at the top and consequently the arch is weak, but they can be used in bonded arches if desired. The two or more rowlock arch is the strongest because the greatest strain comes on the soffit and an arch built of many rowlocks has more brick and less mortar and as many soffits as it has rowlocks. All brick arches should be grouted or at least well slushed up with mortar so as to form when the mortar has set a solid piece of brickwork.

The flat arch or brick lintel, Fig. 91, is so called because, as will be seen in the engraving, it is almost flat on the bottom soffit and top extrados. This arch, both in rough or face brickwork must have the bricks forming the

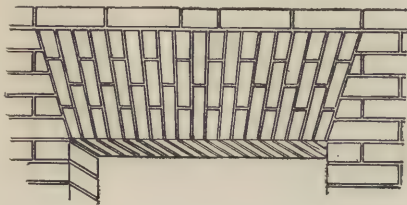


FIG. 91.

"voussoirs" tapered by cutting, grinding or molding to wedge-shape, as seen in the engraving. The bricklaying of a flat arch must be very carefully done, as the rise of the soffit is so slight if the bricks do not adhere tightly, face to face, one or more bricks are liable to slide down and ruin the arch. For the same reason the mortar joints should never be thick, in order to avoid all possible shrinkage of the mortar. The deeper a flat arch is the better and stronger it is, because the strength increases as the depth is increased; for instance, a flat arch 16 inches deep is twice as strong as one 8 inches deep, though flat arches are never used for bearing purposes, only on fronts or ornamental work. The following proportions may be safely followed in laying out flat arches for front work:

When ground to suit the skewback for a flat arch, with radius one and a half times width of opening, as at Fig. 91.

One standard stretcher gives height equal to three courses brick standard size laid flat.

One Roman stretcher gives height equal to six courses Roman size laid flat.

One header, either Standard or Roman, gives a height of $3\frac{1}{4}$ to $3\frac{3}{4}$ inches. Multiples of any of the above give proportionate height. When radius is not as much as $1\frac{1}{2}$ times the width of opening, it still further reduces the height obtained from each brick. When only four inches of reveal is required, face of arch may be made any height desired by grinding apparent headers from stretchers.

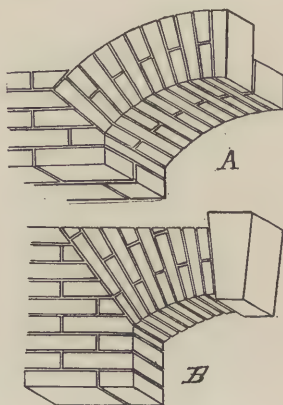


FIG. 91—A AND B.

When flat arches are being ordered from the brick manufacturers, either a detailed drawing should be prepared together with a quarter scale tracing of the entire front or the following measurements be given:

1. Width of opening.
2. Height of fascia in inches or courses of brick.
3. Depth of soffit in inches.
4. Location of centre; to locate centre give any one of the following: a. length of radius to spring of arch; b. length of radius to centre of jamb; c. width of top of arch; d. pitch of heel in degrees.
5. When key, other than brick, is used, give width of the key on jamb line.
6. Give inches, if laid with cut stone in skewback. Give number of courses, if laid with bricks in skewback.

If the voussoirs for brick lintels or camber arches must be cut from regular brick at the building, the best way to proceed is to use a templet shaped to the taper of one voussoir, and set a

bevel for each top and bottom cut for the soffit and extrados.

The Segmental arch for front work A, Fig. 91, resembles that described in Fig. 90-B, and differs from the Segmental arch, with a flat top or extrados, Fig. 91-B, which is rarely used in bearing walls, being mostly employed for decorative purposes in front work, etc. It is a combination of the Segment and flat arches, and has the bricks, forming its voussoirs molded, ground or rubbed to fit as shown in the engraving, where also a stone or terra cotta Keystone is represented, inserted for architectural effect.

If not possible to furnish a drawing, the following measurements should be

and give a neat mechanical appearance, as seen in the engraving. When making the drawings for these arches the following measurements must be accurately figured on each, care being taken that they are correct, as the least deviation will spoil the arch: 1. Radius of circle or width of opening. 2. Width of fascia. 3. Depth of soffit. For piers: 4. Width of pier on base line. 5. Number of arches in each set or number of piers.

The construction of the Elliptic arch in rough brickwork is simple, as the bricks are laid on edge as headers on the centre and carried up rowlock by rowlock, to the desired thickness, but for front work the bricks must be molded

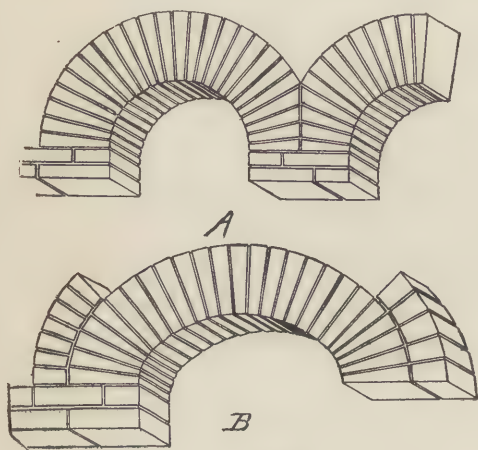


FIG. 92.

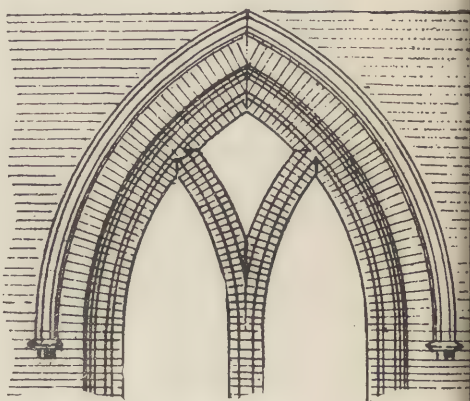


FIG. 93.

given: For Segmental arches, round or flat top. 1. Width of opening. 2. Radius of circle or rise of arch in center. 3. Width of fascia for flat tops measure fascia in center. 4. Depth of soffit. 5. Dimension of key on jamb line. Give inches, if laid with cut stone in skewback. Give number of courses, if laid with bricks in skewbacks. If on piers, give width of pier.

The construction of the arches illustrated in the last two engravings embody much of the detail requisite in turning the two semicircular arches represented at Fig. 92-A, with the exception that those in Fig. 90-A are only one brick laid stretcher-ways in the ring intersecting on a center pier and forming a vertical joint. All the voussoirs for these arches must be specially made from drawings in order that they may be truly and accurately laid,

as before to suit the different radii. Fig. 92-B represents the bricks of an Elliptic arch for front work, to which it is better adapted than to rough work, for the reason that it is structurally a weak arch, and not so economical to build as either the semicircular or Segmental arches, over openings which have weight placed over them. For front brick Elliptic arches always give the following details: Width of opening; each of the three radii; rise or spring of arch; depth of reveal or soffit; height of face; size of joints; if on piers, give width of pier or piers; 3-16 inch unless otherwise specified; when special key is used give dimensions of it; architraves or any rowlock arches; a. with continuous joint, see right hand side; b. with broken joint, see left hand side.

Brick Gothic arches of various forms are mostly employed in Ecclesiastical

edifices, as churches of Gothic design, and, like the foregoing front bricks, are always made from an architect's detail. The utmost care and skill are demanded from the bricklayer in this work; in fact, it is in buildings of this class and character that the art of bricklaying reaches its climax, because brickwork in its application to Gothic architecture is the very perfection of brick detail. See Fig. 93. It may perhaps be claimed that the intermingling of terra cotta with brick gives a more effective elevation than brickwork alone, but the latter, if elaborately treated, always shows the labor and skill expended, both in the manufacturing and laying of the brick. Though the setting of terra cotta is now part of the art of bricklaying, it

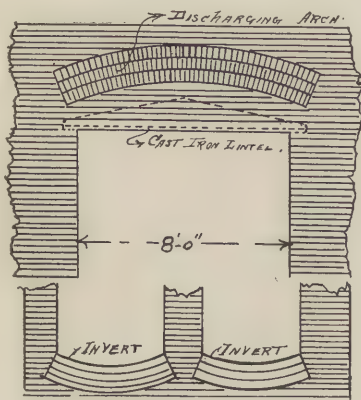


FIG. 94.

is not regarded by bricklayers as the best part of their work, as it does not require as much skill, for the reason that there is always a fitter sent to every job to select and pick out and to fit together the different details from the detailed drawings, so that only the setting in position is left for the bricklayer.

Fig. 94 represents a discharging or relieving arch turned over a wide door opening in a 24-inch interior brick wall for the purpose of relieving the strain upon the cast-iron lintel placed across it by resisting the vertical pressure of the mass of brickwork above, which would fracture the brittle metal. It is built upon a center of brickwork and solidly into the wall, so as to be a part of same.

When ordering arches for front work, all necessary information as to details should be given when anything more

than a simple semi-circular, segment, gothic, or flat arch is wanted, also a full size detail of half of the arch, especially if cut stone or terra cotta is used in connection with the brickwork.

Always furnish details as long as possible in advance of time the arches will be needed. With all necessary bricks in stock, it will take to grind arches two weeks from receipt of order. If moulded shapes are not in stock, and must be made before they are ground for the arches, allow eight weeks after receipt of order.

At the bottom of this illustration readers will perceive I have drawn two inverted brick arches, supporting three brick piers. It will be noticed that these are only segmental arches, represented at Fig. 90-B, turned upside down with the extrados set on a solid bed of concrete or brickwork. These arches are often adopted by engineers and architects for spreading the area of the pier footings or distributing their vertical pressure. The skewbacks, like the arches, are also inverted, and as they constitute bases or foundation for footings, the workmanship of the bricklaying of these arches must be of the very best character and always laid in cement. For greater accuracy the curve of the bottom rowlock should invariably be laid out from a templet, great care being taken to get the skewbacks to the exact radii.

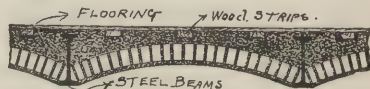


FIG. 95.

Fig. 95 exhibits a Fire-Proof Floor, with Brick Arches, Leveled up with Concrete and Wood Strips. Imbedded for Flooring; and Fig. 96—Hollow Terra



FIG. 96.

Cotta Arch Fire-Proof Floor, with Concrete and Wood Strips Imbedded to Receive Flooring Nails.

At Fig. 97 a very inexpensive system of setting centres for turning the brick or terra cotta arches between I beams will be seen. It consists of 2 inch x 4 inch or 2 inch x 6 inch spruce joists laid lengthways on top and bottom flanges of each I beam; the bottom joist being

hung to that on top by means of 1 inch x 8 inch or $1\frac{1}{4}$ inch x 4 inch spruce cleats or strips. The curved bearers are set on the bottom strips and nailed thereon and the battens are laid on loose edge to edge, thus making the

spaced about six feet apart. Wire nails are the most reliable for this job.

Fig. 98 shows a form of centre with wrought iron suspension hooks and joists carrying the frames for the centre for arches when turned in a heavy Fire-

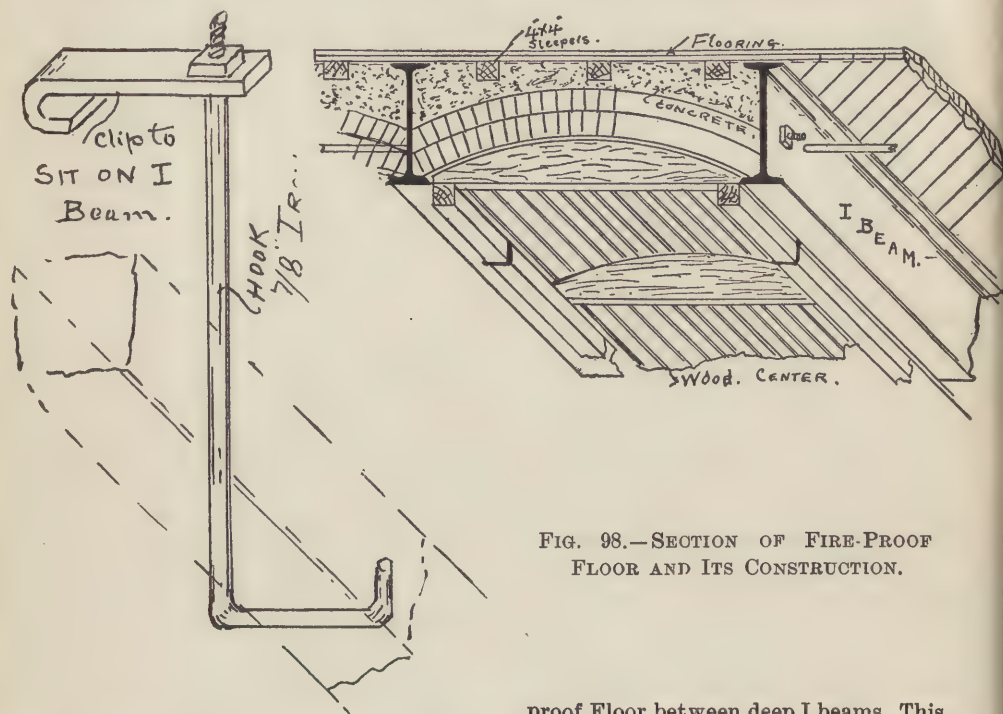


FIG. 98.—SECTION OF FIRE-PROOF FLOOR AND ITS CONSTRUCTION.

centres easily removed from the arch, to the next opening, when the cement has set sufficiently hard to allow it, by simply wedging off the strips from the upper joist. The writer has seen many brick and terra cotta arches turned on

proof Floor between deep I beams. This cut also shows concrete and wood sleepers for floors and bricklayers, wrought iron hanger for carrying centres with clip to catch on flange of steel I beam.

Fig. 99.—Section of Elliptic Brick Arch over 86th Street Transverse Road through Central Park, New York City.

PIERS.

The next important detail to be considered in constructive and "architectural brickwork" is the laying up of piers, or columns of brick, which are used for supporting wood, iron or steel columns, beams and girders and consequently require explanation.

Piers are of three kinds, viz., isolated, connected and battered. By referring to Fig. 100 of the illustrations readers will find an isometrical drawing of an 8 in. by 8 in., or eight inch isolated brick pier, with a stepped-up footing, consisting of three courses of bricks, stepped or set back one inch on each course,

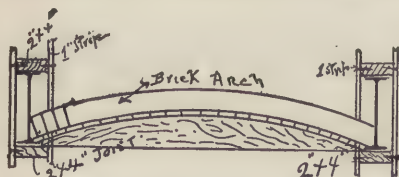


FIG. 97.—METHOD OF SETTING CENTRES FOR FIRE PROOF FLOORS.

this simple and cheap form of centre and it works admirably, carrying both men and material safely. The cleats should be nailed opposite each other on different sides of each beam, and be

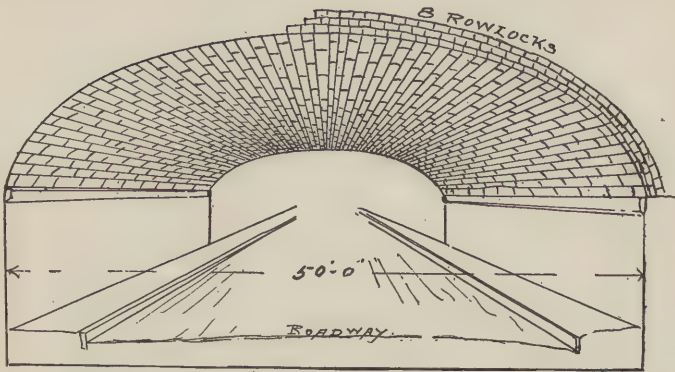


FIG. 99.—SECTION OF BRICK ARCH OVER 86TH STREET TRANSVERSE ROAD, CENTRAL PARK, N. Y. CITY.

which is done to enlarge the area of the base of the pier and distribute the bearing weight with a greater area.

The construction necessary in building this pier is very simple, as the bricks

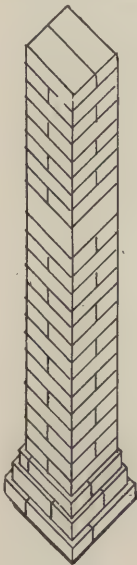


FIG. 100.—8-IN. BRICK PIER WITH BOND STONE.

are laid alternately header and stretcher on each course, two bricks to a course, and the pier has a bond stone set in at a height of 2 feet 6 inches from its base. These bond stones are inserted for the purpose of giving greater coherency to the pier by connecting its constituent parts or bricks together, but they might

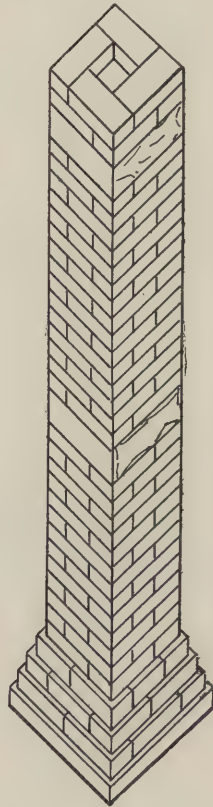


FIG. 101.—12-IN. BRICK PIER.

safely be omitted in 8-inch isolated brick piers, as there are scarcely sufficient

bricks in width to require them, unless the pier be high, in which case they should be inserted, but no isolated brick pier should exceed in height 10 times its least dimensions. It is now the custom to insert them in all brick piers less

wall, thus crossing the bonds. The 4½-inch bond stones to space out about 2 feet 6 inches apart will occur about every 15 courses.

The necessity for the bond stones will be appreciated by referring to Fig. 102, a 16 x 16-inch isolated brick pier, the construction of which resembles the bricklaying shown in Fig. 101, and should have the heading courses laid every

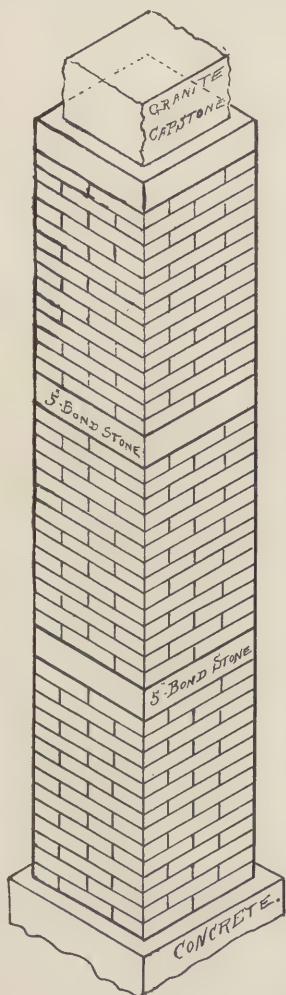


FIG. 102.—16 x 16 IN. BRICK PIER.

than nine square feet in their sectional area.

Fig. 101 represents a 12 by 12-inch isolated brick pier, built with bricks, so as to show headers and stretchers on all four sides. A stronger job may be obtained by inserting a course of headers in every sixth course, as in a straight

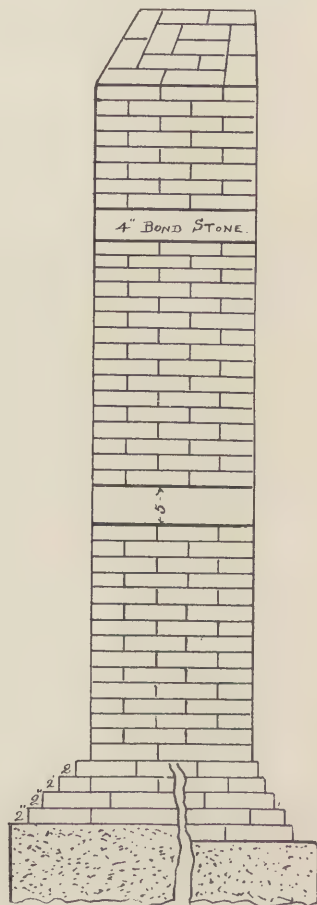


FIG. 103.—20-IN. BRICK PIER.

sixth course for greater strength. In this engraving also three bond stones are shown, with a granite templet, or capstone, set on top of the topmost stone, for the purpose of receiving the base of a cast iron or steel column, or girders. The setting of these capstones and templets for columns or girders,

whether they be in a continuous wall or on isolated piers, also devolves on the bricklayer, and it is his duty to see that they are thoroughly bedded in. Portland cement mortar and rubbed down on the upper bond stone until all the air in the mortar is driven out and sufficient vacuum formed between the two stones to give a strong, immovable bond. Another very important detail which needs care in the workmanship is the setting

work must not be jarred or the bonds broken. A hollow or void in the middle of the stone will certainly mean its cracking when the superposed weight it must carry is placed above it. For this reason the proper setting of bond stones is a serious matter, as they are essential to ensure the full carrying capacity of each pier. Bond stones should always be the full size of the horizontal sectional area of the pier, be spaced not more than 30 inches apart, and not less than 4 inches thick.

Cast iron plates are sometimes used to bond brick piers, but their liability to rapid corrosion renders them objectionable for safe building.

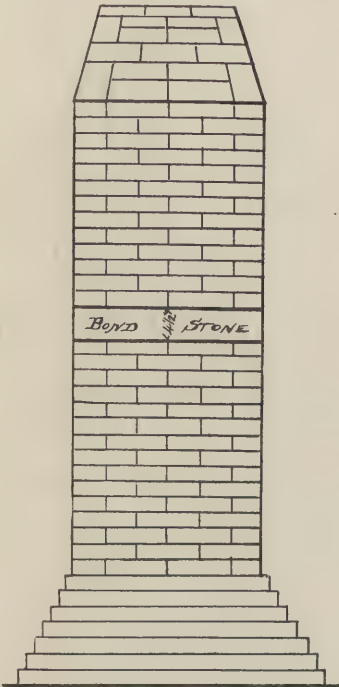


FIG. 104—24-IN. BRICK PIER.

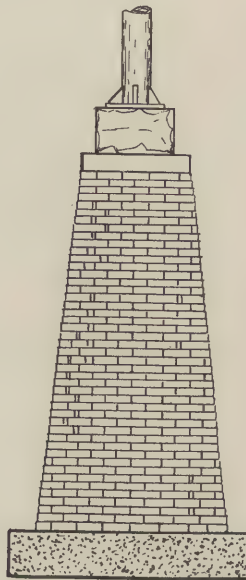


FIG. 105—BATTERED BRICK PIER.

of the bond stones and grouting by courses. Every course should have a slushing with liquid cement thoroughly worked into all joints. These important factors in isolated piers are usually of bluestone or marble, and will require to be good flat stones, out of wind and dressed square and flat. When setting, they should be carefully laid in position on a full bed of good, strong cement mortar, and gently rubbed or tapped down until the mortar oozes from beneath on all four sides, care being taken that the joint is not too thick; the stone is kept level and flush all around with the four faces of the pier, but the brick-

The foregoing description applies in the same details to the 20x20-inch isolated brick pier illustrated at Fig. 103, where the base of the brickwork rests on a Portland cement concrete footing, and is shown here stepped back in one inch steppings on the right side and two-inch steppings on the left side, thus giving greater stability to the pier. The bond stones are respectively 4 and 5 inches thick, and approximately 2 feet 6 inches or 15 courses of brick apart.

Fig. 104 represents an isolated 24x24-inch pier with stepped up base and one bond stone, set 15 courses up. This large pier is here represented in course

of construction, and involves much bricklaying and consequently careful bonding and full grouting. Connected piers are those bonded to walls and strengthened for bearing purposes with bond stones properly spaced.

The strongest brick pier which it is possible to construct is represented in elevation at Fig. 105, where a battered or tapered brick pier is depicted diminishing by $\frac{1}{2}$ inch steppings from the base to the top, and capped with a bond stone, on which a granite block or capstone is set for the purpose of supporting a cast-iron column, the base resting and bedded in liquid cement on the top side of the granite block, which is accurately leveled off to receive it. Brick piers of this class and form, when properly built,

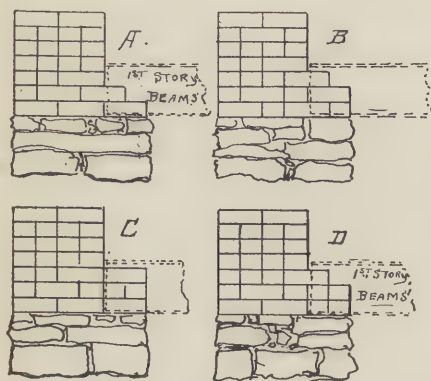


FIG. 106—BASE OF WALLS OR PIERS WITH DIFFERENT STEPPINGS.

bonded and grouted have the greatest bearing capacity of any constructed, and when possible should be used, but the expense involved in the bricklaying and the extra space they occupy discriminates against their universal adoption. However, for engineering works or for isolated piers on compressible bottoms of clay or any nature where it is necessary to distribute the area of pressure, they are invaluable.

Isolated brick piers and skewbacks adopted for the purpose of receiving the thrust of arches and vaulting may also be built, but as they embody the construction described in the foregoing, with the addition of cutting the skewbacks at the top to suit the radii of the arches, no further description is necessary. In a similar way piers of front, glazed, enameled or molded bricks can also be built, but, if intended to sustain

weight and be of large sectional area, with a rough brick core, then as the core supports the weight it should be most carefully built, especially if the faces be laid in running bond to form a veneering or finished facework.

Front brick piers with bond stones of Indiana limestone, or any other stone of an absorbent nature, will require a layer of mastic cement, Lafarge or Puzzalona on top, bottom and rear sides to

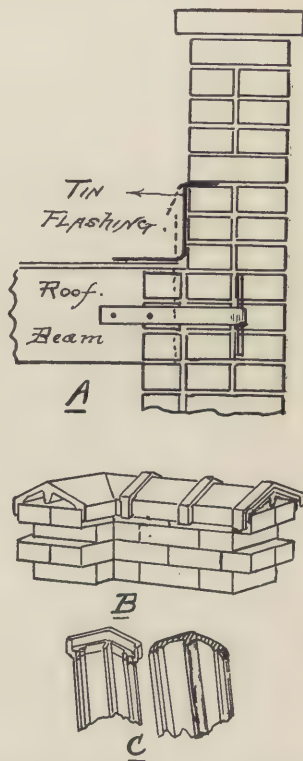


FIG. 107—PARAPET WALLS COPED WITH TERRA COTTA AND STONE.

prevent the capillary attraction in the stone from absorbing the dark liquid of the cement into the stone and its consequent discoloration, and if the pier be anchored or bonded to a gable or party wall it is best laid up in strong lime mortar.

Brick piers which are not isolated or over 9 square feet in area and are bonded or anchored to walls occurring at right angles or otherwise, require the same laying as described for straight

walls, and I will now close this subject by referring the reader to the four different methods of stepped-up work illustrated in Fig. 106, A, B, C and D. A represents the foot or commencement of a 16-inch brick wall for a city dwelling or tenement; on top of the stone foundation, with the first and second courses stepped back, thus distributing the pressure over the top of the stone wall. Similarly with diagram B, C shows how the brickwork as laid has no structural value, 8 inches of strength being lost, and D shows how 4 inches may be lost. In concluding this subject of piers, I

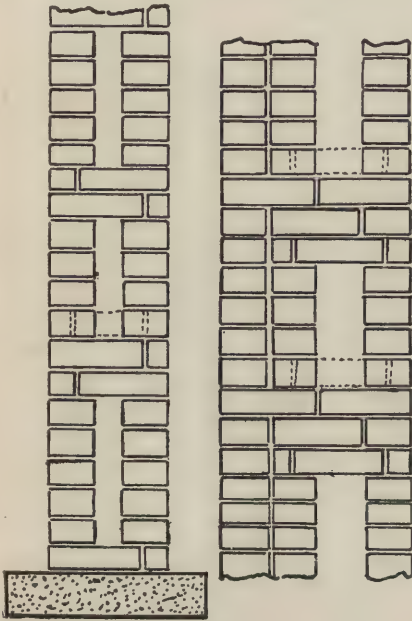


FIG. 108—10x16-IN. HOLLOW WALLS.

would advise that the introduction of "Rowlocks" or bricks on edge, be avoided as much as possible when building piers.

Parapet walls, or fire walls, as they are frequently termed, are those seen in the engraving Fig. 107, which are carried up sufficiently high above the level of the roof to prevent fire, should any break out in the adjoining building, from spreading or working over. These walls are built 8 inches thick and from 12 to 24 inches high above the roof for rear, party and gable walls; and from 36 to 42 inches for light shaft and court walls, 4 ins. of brick work being always kept between the ends of the roof beams

to prevent the smoke, blaze or sparks from traveling from one tier of beams to the next. The bricks in parapet and fire walls should invariably be laid in cement mortar and coped or covered with terra cotta, stone or metal to prevent rain water, frost, etc., from percolating down into the mortar joints and causing early disintegration of the work. A in the engraving shows a section of 12-inch bearing wall with 8-inch wall and roof beams and flashing. The blue-stone or marble coping B is a corner, and C a bottom view of terra cotta coping.

Hollow walls: These walls are of value for the economical construction of ice houses, damp-proof structures or any purpose where it is desirable to obtain a wall or rather two parallel walls with a vacant or hollow air space between, as Fig. 108. The bricklaying necessary for them is comparatively simple in character, as the walls being non-bearing are simply tied together at every fifth or sixth course by headers spaced every three or four feet, longitudinally, and a space of from two to four inches left between the inside faces of the parallel walls. For thin partition walls, two one-brick thicknesses will be sufficient, but for thicker walls two or more thicknesses of 8 inches may be built with a 4 inch intervening space. Sometimes the brick bonding is omitted and iron or steel ties are substituted, to tie the walls together.

The following excerpt from the New York Building Code governs the construction of piers in that city, and will be found useful in connection with the foregoing:)

"Every pier built of brick, containing less than nine superficial feet at the base, supporting any beam, girder, arch or column on which a wall rests, or lintel spanning an opening over ten feet and supporting a wall, shall at intervals of not over thirty inches apart in height have built into it a bond stone not less than four inches thick, or a cast-iron plate of sufficient strength, and the full size of the piers. For piers fronting on a street the bond stones may conform with the kind of stone used for the trimmings of the front. Capstones of cut granite or bluestone, proportioned to the weight to be carried, but not less than five inches in thickness, by the full size of the pier, or cast-iron plates of equal strength by the full size of the pier, shall be set under all columns or girders, except where a 4-inch bond stone is placed immediately below said

capstone, in which case the capstone may be reduced in horizontal dimensions at the discretion of the Commissioner of Buildings having jurisdiction.

are generally built for coal smoke flues 8x8 inches or 8x12 inches, inside measurement, or a brick wide and a brick and a half long, and a partition, one

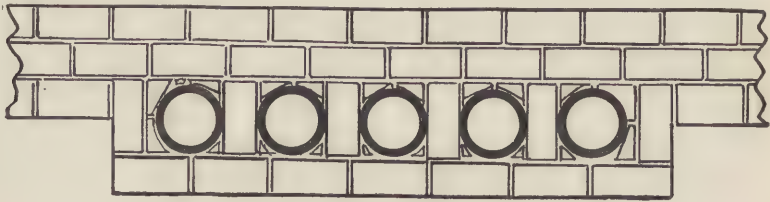


FIG. 109.—CHIMNEY BREAST WITH FLUES.

Isolated brick piers shall not exceed in height ten times their least dimensions. Stone posts for the support of posts or columns above shall not be used in the interior of any building. Where walls or piers are built of coursed stones, with dressed level beds and vertical joints, the Department of Buildings shall have the right to allow such walls or piers to be built of a less thickness than specified for brickwork, but in no case shall said walls or piers be less than three-quarters of the thickness provided for brickwork.

"In all brick walls every sixth course shall be a heading course, except where walls are faced with brick in running bond, in which latter case, every sixth course shall be bonded into the backing by cutting the course of the face brick and putting in diagonal headers behind the same, or by splitting the face brick in half and backing the same with a continuous row of headers. Where face brick is used of a different thickness from the brick used for the backing, the courses of the exterior and interior brickwork shall be brought to a level bed at intervals of not more than ten courses in height of the face brick, and the face brick shall be properly tied to the backing by a heading course of the face brick. All bearing walls faced with brick laid in running bond shall be four inches thicker than the walls are required to be under any section of this Code."

CHAPTER VIII.

BUILDING CHIMNEYS, FLUES AND CHIMNEY BREASTS.

COMING now to the brick construction of the above essential details of buildings, I would state that the sizes of smoke flues are regulated by the purpose for which they are used. If the flues be not lined they

brick thick, is carried up between them, in the manner represented at Fig. 109. This engraving shows the section in

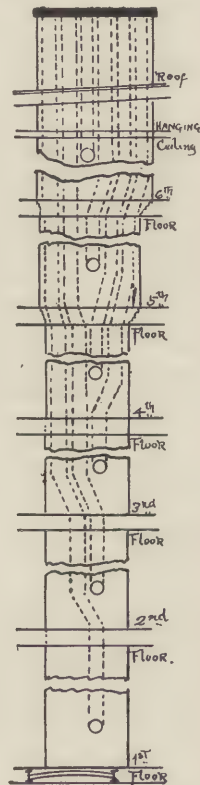


FIG. 110.—ELEVATION OF CHIMNEY BREAST AND FLUES.

detail of the full brick construction of a modern chimney breast, built on the 5th floor of an apartment house. The side or gable wall is 12 inches thick and

the chimney, containing 5 flues, is projected into the room 8 inches, which is done for the purpose of obtaining 8 inches of brickwork on the outside or face of the wall for necessary strength. This projection is termed the "Chimney Breast," and is necessary to contain the flues. It will be observed that the flues are lined with fire clay or terra cotta "linings," which are short lengths of cylindrical shape, set end on end, from the mouth or intake of each flue at the bottom to the outlet at the chimney top, thus forming a clean, smooth conduit for the fire and smoke from stove or fireplace to the outer air. Each room or fireplace for gas or coal should have its

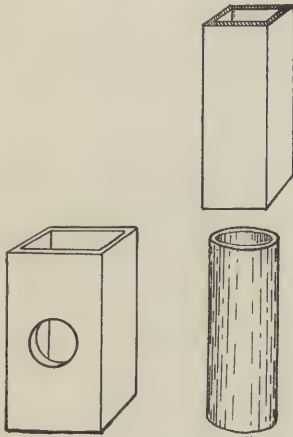
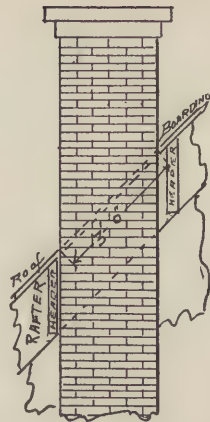


FIG. 111.—ROUND AND SQUARE FLUE LININGS.

own flue, as it has been found they will not draw properly if carried into each other at any point. At Fig. 110, I illustrate the elevation of the chimney breast and flues which is given to the bricklayer with the set of plans furnished by the architect, to enable the bricklayer to build the chimneys from story to story as the walls of the structure are laid up. The direction of the flues, their positions in the breasts, and offsets at each story, are here clearly defined, thus enabling the bricklayer to keep the several lines as designed. Fig. 111 shows the different forms of flue lining or pipes at present in use. They are from 20 to 30 inches long and of the following dimensions of sectional area, round, square or buckeye, with corners slightly rounded as desired:



— ELEVATION —

PLAN of Chimney.

FIG. 112.

FLUE LINING.

Round—(Without sockets)—Inside measure.

6 ins.	9 ins.	15 ins.	21 ins.
7 "	10 "	18 "	24 "
8 "	12 "	20 "	

Openings 4 times price of 1 ft. straight pipe.

Square—Outside measure.

$4\frac{1}{2} \times 8\frac{1}{2}$ ins.	$7\frac{1}{2} \times 7\frac{1}{2}$ ins.	13×13 ins.
$4\frac{1}{2} \times 13$ "	$8\frac{1}{2} \times 8\frac{1}{2}$ "	13×18 "
$4\frac{1}{2} \times 18$ "	$8\frac{1}{2} \times 13$ "	18×18 "
6×12 "	$8\frac{1}{2} \times 18$ "	

Openings 3 times price of 1 ft. of pipe.

Smaller sizes for gas stove flues are now made and sold by all dealers in masons' materials.

The square with rounded corners is the most desirable for square flues, as the soot does not accumulate in the corners and clog the conduit. Parging or plastering flues without linings should never be done, as it is liable to bake hard and drop off, thus forming crevices. All joints of the interiors of flue shafts should be struck smooth.

Care also should be taken when gathering over or corbelling over for fireplaces, as they diminish to the width of the flue. The curve should be easy and not have space enough left in the throat of the flue for air to lodge. Every flue to draw well should be built the same size from bottom to top, or a little smaller towards the top, have no sudden bends, and a smooth interior surface.

All flue linings should invariably be carried at least a foot above the level of the top of the roof beams, and all chimneys carried above the highest of the roofs and buildings in close proximity, to avoid the possibility of down draft, which is caused by the wind ricocheting against the surface of the highest chimney; also all chimneys should be coped with stone, terra cotta or iron, as shown at Fig. 112. Furnace flues, or those designed to sustain great heats, are usually of larger sectional area, and should be lined up with firebrick 20 or 25 feet from the mouth or intake.

Not less than eight inches of brickwork is necessary between smoke flues and wooden beams to obviate all possibility of the beams igniting and causing a fire between them.

CHAPTER IX.

ANCHORING, BRACING AND FURRING
BRICK WALLS.

Concerning the bracing of walls after they are laid up to the required level of the tier of beams above, I would state that the methods generally followed are

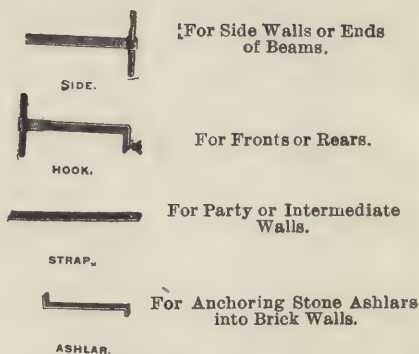


FIG. 113.—ANCHORS.

SIZES OF WROUGHT IRON BUILDING
ANCHORS.*Side.*

1 in. $\times \frac{1}{2}$ in.	$1\frac{1}{2}$ ins. $\times \frac{3}{8}$ in.
$1\frac{1}{2}$ ins. $\times \frac{1}{2}$ "	$1\frac{1}{2}$ " $\times \frac{1}{2}$ "
$1\frac{1}{2}$ " $\times \frac{3}{8}$ "	2 " $\times \frac{1}{2}$ "
$1\frac{1}{2}$ " $\times \frac{1}{2}$ "	

Wall or hook.

1 in. $\times \frac{1}{2}$ in.	$1\frac{1}{2}$ ins. $\times \frac{3}{8}$ in.
$1\frac{1}{2}$ ins. $\times \frac{1}{2}$ "	$1\frac{1}{2}$ " $\times \frac{1}{2}$ "
$1\frac{1}{2}$ " $\times \frac{3}{8}$ "	2 " $\times \frac{1}{2}$ "
$1\frac{1}{2}$ " $\times \frac{1}{2}$ "	

Strap.

$1\frac{1}{2}$ ins. $\times \frac{1}{2}$ in.	$1\frac{1}{2}$ ins. $\times \frac{1}{2}$ in.
$1\frac{1}{2}$ " $\times \frac{3}{8}$ "	2 " $\times \frac{3}{8}$ "
$1\frac{1}{2}$ " $\times \frac{1}{2}$ "	2 " $\times \frac{1}{2}$ "
$1\frac{1}{2}$ " $\times \frac{3}{8}$ "	

Length: 12 in., 14 in., 16 in., 18 in., 20 in., 24 in., 30 in., and 36 in.

either to build 2 foot strips of 2×4 studing into the wall at about two-thirds of its height between stories and to these to nail scantling or planks, placed diagonally against the inside face of the wall, which are braced and nailed to the floor beams below. These should be spaced not over 10 feet apart and be made solid and stable to keep the green walls from being jarred while the beams are being set, or dangerously vibrated by the springing of the hod-hoisting machine. Twelve-inch walls, and sometimes walls of greater thickness, should be braced while the mortar is soft, by placing plank against them every ten feet and shoring the plank from the floor beams. This bracing is particularly important where newly built walls without openings are exposed to the wind.

For the same reasons, a centre line of temporary fore and aft partitions should be inserted before the hod hoisting machine starts running, or the laborers commence carrying stuff across the floor beams from the machine, as both are likely to spring the walls to a bulge, force them out of plumb, or start the joints.

As to the methods of anchoring brick walls, or securing them to the beams and girders, there is no difference of opinion among experts about its importance in maintaining the stability and safety of brick walls, so on this account I here give the best modern practice now prevailing in this important detail.

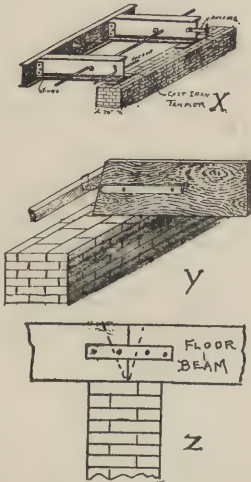


FIG. 114.—WALL ANCHORS APPLIED.

Fig. 113 of the engravings shows the anchors mostly employed with their various applications and sizes, and Fig. 114 the practical work which they do in holding the walls of a building together. X, Fig. 114, represents part of the first floor tier of iron or steel beams of an apartment or dwelling house, set on cast iron templets on a cellar or basement wall, and two styels of anchors, one being a pin anchor, and one a strap anchor, bolted to the web of the beam; the strap anchor is more expensive than the pin, but it has a better holding, and allows the beams to be moved at any time without injuring the wall.

Y shows a form of anchor employed in the western States, but the use of the

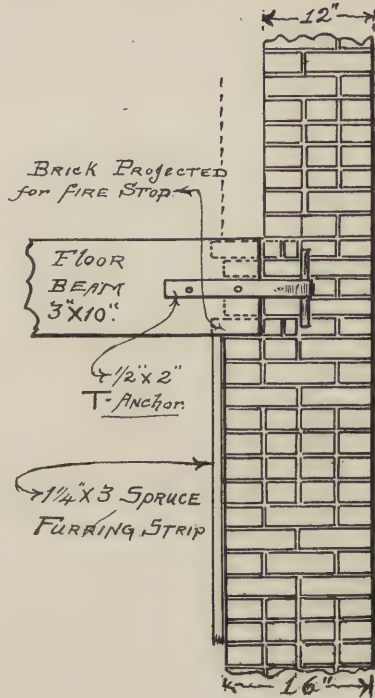


FIG. 115.—SECTION OF WALL AND ANCHORED BEAMS.

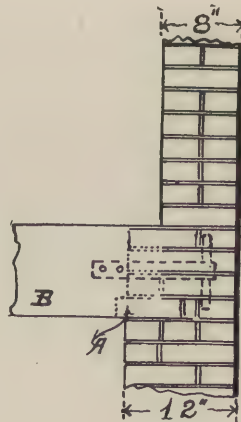


FIG. 116.—12 AND 8-IN. WALLS ANCHORED.

wooden strip built in the wall is obsolete and not good practice, as it shrinks and rots.

Z in the same engraving shows how strap anchors are nailed to abutting floor beams.

In order to give the reader a fuller explanation of the necessity of thoroughly tying side walls as they are built, I would refer him to the section of a side wall, Fig. 115, where a wall steps off from 16 to

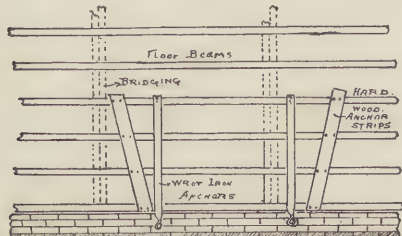


FIG. 117—PLAN OF FLOORS SHOWING METHOD OF ANCHORING FRONT AND REAR WALLS TO BEAM.

FIG. 117—PLAN OF FLOORS SHOWING METHOD OF ANCHORING FRONT AND REAR WALLS TO BEAM.

12 inches at the tier of floor beams, with the upper and lower courses at top and bottom of beams projecting $1\frac{1}{2}$ inches to form a fire stop above the wooden wall

furring. Here the anchor only goes 4 inches into the 12-inch wall, but has 8 inches in the 16 inch wall. All anchors should have at least 8 inches in walls of 12 inches or over to make a safe wall; they should be placed if possible on every 4th beam, and not over 6 feet apart and be well nailed to beams and brickwork

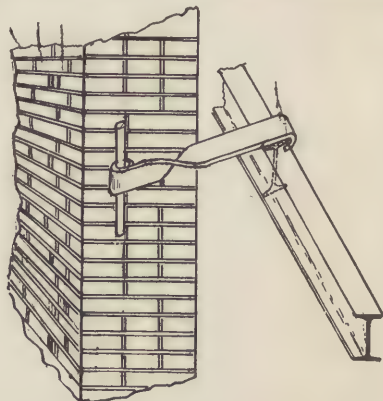


FIG. 118—ANCHOR FOR STEEL BEAMS.

made good against the cross bar, also T and strap anchors where they occur on side party and intermediate walls on abutting beams should be nailed on the

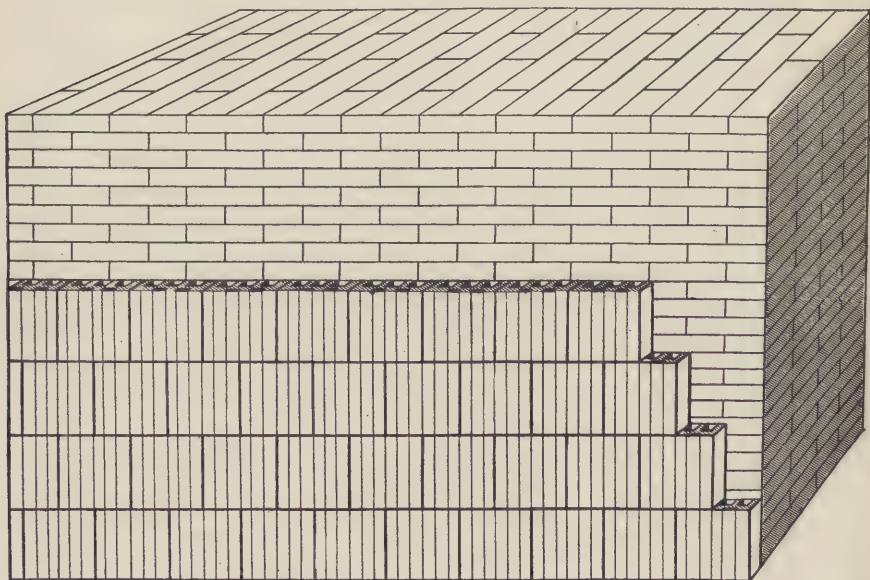


FIG. 119—HOLLOW BRICK OR POROUS TERRA COTTA FURRING.

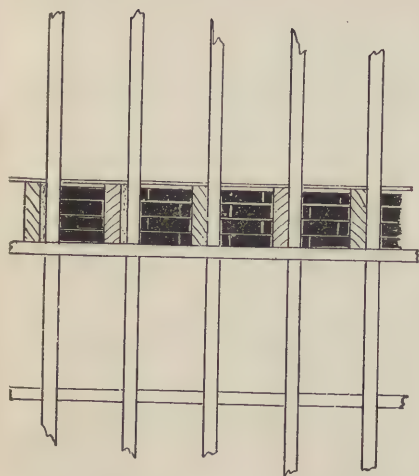


FIG. 120—COMMON METHOD OF FIRE-PROOFING PARTITIONS.

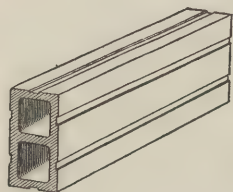
same line of beams. Fig. 116 is the section of a 12 and 8-inch wall similarly anchored.

Coming now to the subject of securing front walls laid up with face brickwork I would draw attention to the way this is done by referring to Fig. 117 where the positions of the anchors are designated, as they hook over the fourth beam back from the front. These anchors are spe-

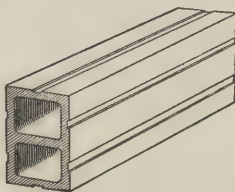
cially made long to reach back over at least 4 or 5 beams and are of thicker and wider iron than those represented in Fig. 113. The beams are prevented from springing by inserting and nailing a hardwood strip placed diagonally and let flush into the top of the floor beams.

Fig. 118 of the illustrations gives the form of hook anchor mostly used to anchor walls to the beams and girders of steel frames used in construction of high buildings. They are made long or short as desired. For terra cotta, stone, ashlar columns or other special architectural details, special anchors are usually made to meet special requirements, but the inside end is generally wrought with a hook to hook over the top or bottom flange of the beams or girders as specified.

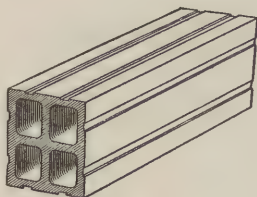
Fig. 120 illustrates the simplest modern method in use for preventing fire from traveling up from one line of lath and plaster partition to that directly over it, above the tier of beams. The scheme is to fill in the spaces between the beams with brick and mortar, in the way represented in the engraving, the brick being laid on the top plate of the partition below. When it is necessary to make a partition entirely fireproof, horizontal pieces of bridging are inserted, about two or three rows in the entire height, and on these pieces the bricks are laid, breaking joint in the bond, so as to stiffen the whole partition, or the



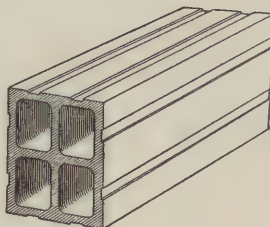
3 x 6 x 12
8 x 8 x 12



4 x 6 x 12
4 x 8 x 12



5 x 6 x 12
5 x 7 x 12



6 x 6 x 12
6 x 8 x 12

FIG. 121—HOLLOW BRICK FOR PARTITIONS.

spaces are filled up with mineral wool. When the partition is constructed of studding set on flat or only $2\frac{1}{2}$ inches thick, the bricks are laid on the top of each other, edge to edge.

FIREPROOFING WOOD FLOORS, PARTITIONS AND DOORS.

In connection with floors I would here draw attention to the method of *fireproofing*, or deafening floors, which consists of a series of wood cleats or strips nailed about four inches down on each side of the floor beams. On these strips $\frac{3}{4}$ -inch or 1-inch boards are placed and nailed, so as to form a shell or pocket between the floor and ceiling below. These pockets are afterwards filled in with a concrete made of ashes and cement, thus rendering the floor both fire and sound-proof. The writer believes, however, that the water in the concrete is absorbed by the pores of the wood, and after a time a dry-rot ensues which is sure to injure the wood, so as to impair its strength and render it unsafe. Care, then, should be taken not to put in the concrete slimy or very wet.

Hard and porous Furring Blocks are sold, as Fig 121, $1\frac{1}{2} \times 12 \times 12$ and $2 \times 12 \times 12$. Haverstraw size Hollow Brick in stock for furring or lining outside walls, are obtainable likewise. In connection with the last I might quote from a paper presented before a recent meeting of the Iowa Tile and Brick Association, by L. W. Denison, some very interesting points being made relative to the advantages of hollow brick. Among other things the author said:

"The airspace makes a dry frost proof wall. The plaster is applied direct to the brick, thus cutting off all expense of lathing. They take one-third less mortar than common brick. In a 12-inch wall we have three separate air spaces as a non-conductor of heat and cold. The hollow brick at common brick measure are much lighter, weighing only 2.63 pounds, while our common brick weigh $4\frac{1}{2}$ pounds; thus they have advantages over common brick in freight, hauling, handling and hoisting to place in the building. Fifty per cent. more wall can be laid per day of hollow brick than of common brick." See Fig. 119.

CHAPTER X.

GENERAL, IMPORTANT AND MISCELLANEOUS DETAILS OF BRICKWORK.

THE following is a list of many of the tools and materials required by the mason and bricklayer:

Hard Brick,	Dirt removed,
Front Brick,	Asphalt, Tar,
Glazed or Tile Brick,	Scaffolding and Horses,
Special Brick,	Ladders,
Lime, Cement,	Hose,
Portland Cement,	Water Pails,
White Sand,	Hoes,
Brown Sand,	Shovels, Spades,
Stone, Slates,	Pickaxes,
Gravel,	Crowbars,
Brick Mortar,	Pulley Blocks,
Scratch Mortar,	Rope,
Brown Mortar,	Hod Hoister,
White Mortar,	Engineer,
Plaster, Lath,	Wheelbarrows,
Hair, Nails,	Hand-barrows,
Wire Lath and Staples,	Hods,
Old materials,	Tampers or Rammers.

Every foreman should make out this list, and check off and keep count as he needs and uses supplies, etc.

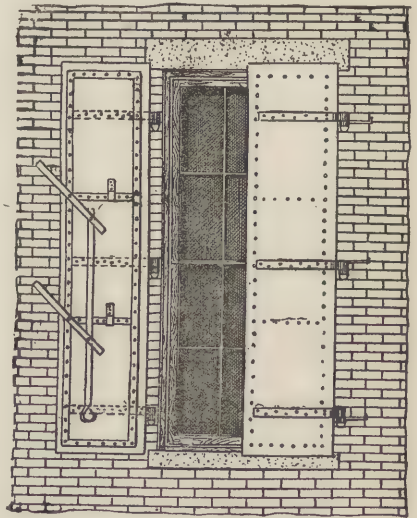


FIG. 122.

Storage warehouses and other fire-proof buildings have their windows equipped with outside folding iron shutters to prevent fire from spreading

from buildings. These shutters are hung on cast iron eyes the size of a brick, which are built into the reveals in the way represented in the engraving.

Fig. 123 illustrates how a damp course is built on top of the foundation walls to prevent cold and damp air from going

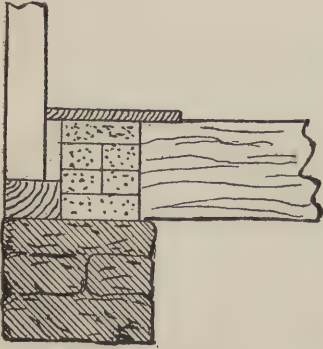


FIG. 123.

up into the floor and rooms on the first story. This method is valuable, and applicable to frame houses.

CONSTRUCTION OF BAKE OVENS.

Regarding this important part of a bricklayer's art, I would refer the reader to the illustration Fig. 124, which gives a cross section of a good oven which I have seen constructed.

As will be seen it is made up of 3 main walls or sides, namely, the front and two sides, the fourth side or back being the side wall of the building containing the flue. The side walls were very thick, that on the left 16 inches and on the right containing the flue 24 inches. The base or footing was of concrete. The space inside the walls was first filled in with coarse sand or gravel, topped out with a layer of concrete, on which the fire clay floor tile were bedded, as seen in the engraving. The tie rods and strengthening plates having been set, the oven chamber space was filled in with dry sand, which being thoroughly stamped down was shaped on top to the curve of the firebrick arch or crown, which was turned on this sand centre, Fig. 124.

A wooden centre would also answer this purpose, and many oven crowns are done this way, as the centre is easily burnt out when the arch is set, whereas the sand centre will require to be dug out with a hoe. The arch is somewhat of an elliptic curve with the bricks set on end in a plaster of paris grout. When all laid, the whole top surface or extra-

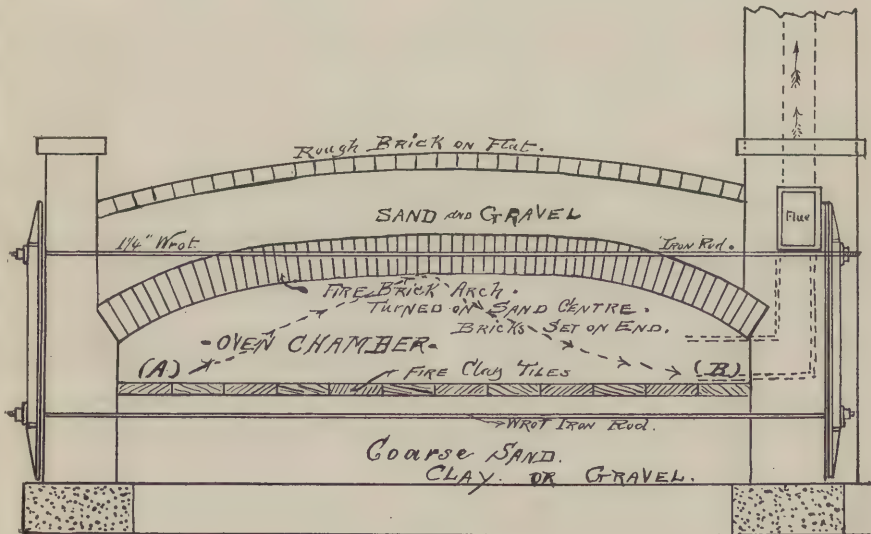


FIG. 124.

dos is thickly coated over with a layer of cement. On top of this sand and gravel was filled in with a top dressing of soft clay and finished with a coat of cement and asphalt, the whole being topped out with fire brick on flat bedded in cement.

The dotted lines from A to B show the direction of the heat, the fire box being set at A and so situated that the heat traveled from A to the back and filled the entire oven chamber, afterwards passing up into the intake of the flue B and thence up the flue of the smoke stack. When ovens are built in the ground, as under sidewalks or on the rears of houses, the tie rods and plates are omitted, as the side walls cannot spread under thrust of the crown arch. The oven section shown in Fig. 124 was built on the floor, and having no side resistance, needed the plates and rods.

LINING BOILERS.

This is another matter which demands the skill of the bricklayer but as there is no special detail requisite in addition to those already described, it needs no special description.

BRICKLAYERS' SCAFFOLDS AND THEIR CONSTRUCTION.

The great increase in the height of buildings, and the material methods of construction, have so changed the methods of scaffolding in modern build-

ings that a short dissertation on the methods now employed may prove of service.

Fig. 125 of the illustrations shows a very convenient form of scaffold which can be adopted when doing any kind of work on the outside walls of a brick or stone building, and it is so simple as to be rapidly and easily put together. Reference to Figs. 125 and 126 will show that it consists of an ordinary 2x8, 2x10, or 2x12 sound spruce beam projected out through each window opening about half or one-third of its length, with its bottom edge resting on the sill of the window frame. The beam is kept from tipping by a wrought iron disconnecting double hook in two halves, the bottom hooking under a floor beam and the top over the inside end of the scaffold beam or plank. This disconnecting hook is made as represented in Fig. 126, of $\frac{1}{2}$ inch by 2 inch wrought iron and bolted together with one or two $\frac{1}{4}$ bolts, as seen in the engraving. A, Fig. 125, is the end view of the floor beam, and C, one bolt. E is a bolt placed under the bottom edge of the plank to prevent its dropping out of the hook. F is the scaffolding planks placed on the top edge outside the wall and G is the cross section of a piece of 2x4 placed and nailed so as to wedge the cantilever beam against one side of the window frame.

This scaffold may be constructed without the wrought iron hook in the manner which is shown at the dotted line. B is a stout piece to fit over of 3x6 inch spruce timber notched out or nailed to

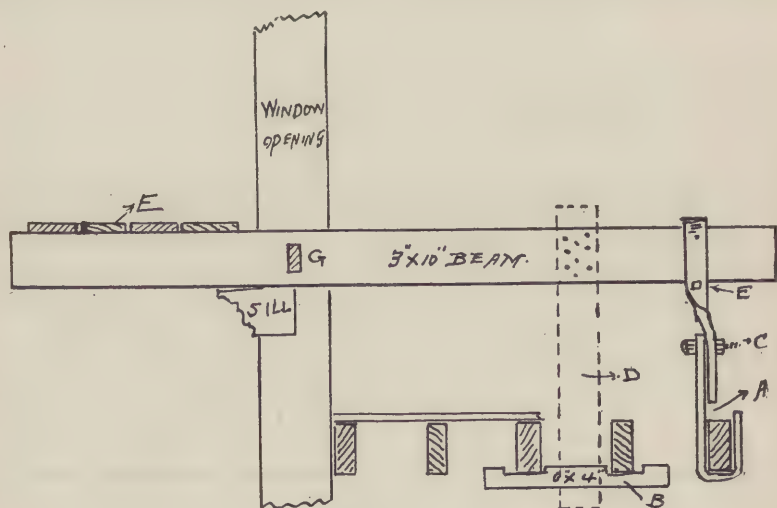


FIG. 125.

the bottom edges of two floor beams and on each side of this two boards are nailed, being also nailed to the side of the plank above, thus holding it firmly in place. This is an exceedingly simple and strong form of cantilever scaffold, but not so strong or reliable as the hook. In closing this description I would state that this form of cantilevering out for scaffolds is in daily use in most of the

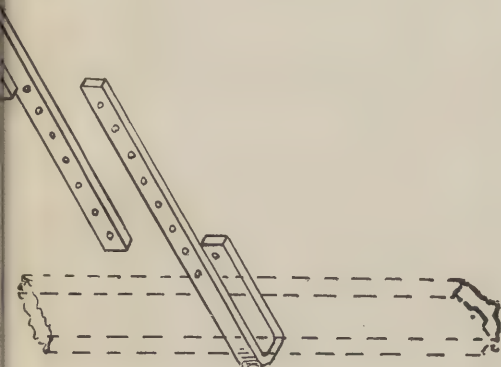


FIG. 124.

cities above the first, second and third stories, especially on the very high buildings, and as its safety and carrying capacity depend entirely on the tensile strength of the bearing plank, the greatest of care should be taken to only place the soundest of timbers in this important position, lest one should happen to break and cause a fearful fall.

Self-supporting stationary scaffolds should be formed of sound uprights and *diagonal* bracing for uprights 3x3, 3x4, 4x4, or 6x6 inch square spruce timbers, sizes according to the height, or the usual Pole and Putlog Scaffold may

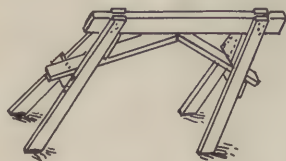


FIG. 127.

be built. When it is desired to raise higher, the mason's horse, Fig. 127, or a series of them, may be employed.

Fig. 128 conveys, better than any written description, the method termed "CORBELLING OUT," or in other words the method employed by bricklayers in projecting or bracketing out brickwork beyond the face of the wall. The chimney here depicted is corbelled out 10 inches outside the face line of the gable by 1 inch projections on each course.

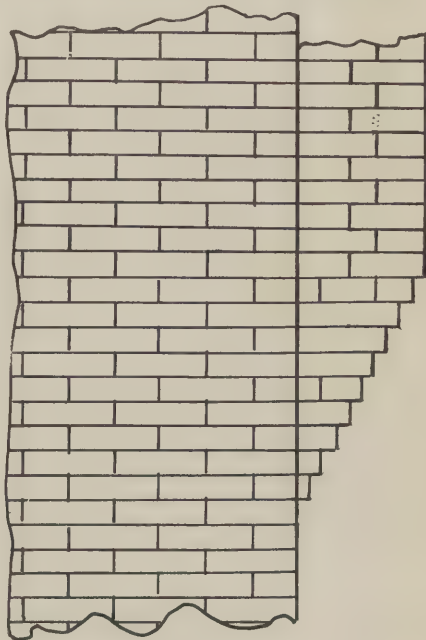


FIG. 128.

Great care must be used to get the bottom courses properly bonded into the wall proper.

The weight of wall per foot in height of wall is as follows:

8-in. brick wall, weight per ft.	77 lbs.
12 " " " "	115 "
16 " " " "	153 "
20 " " " "	192 "
24 " " " "	230 "
Brown stone, 4 inches,	57 pounds
" " 8 "	114 "
" " 12 "	170 "
Granite " per foot,	166 "
White marble, " "	168 "

If this weight is not equally distributed, double it.

Should it sustain a chimney or other weight, add the additional weight in all cases

Deduct for windows only half weight; that is, take out of the weight imposed

on beam, lintel or girder, but half the actual space which the windows will occupy.

NOTE.—Should a pier rest on or about the middle of beam, lintel or girder, the weight must not be considered to be equally distributed. In computing the weight of a brick arch, estimate a 4-inch arch as equal in weight to an 8-inch thick wall, and an 8-inch thick arch as equal in weight to a 12-inch thick wall, on a straight line. This additional weight is to make allowance for the weight of material required to fill up on a level with the crown of the arch. Make allowance for any material placed above the crown of the arch.

Bricks lying in uncovered piles on the street or lot in front of or adjacent to a building, which have been exposed to the heavy rains of one, two or more days' duration, should not be used or laid in walls until dried by exposure to the dry wind and sun. If laid too wet the wall is liable to slide in the joints.

TO CONSTRUCT AN ECONOMICAL FIRE-PROOF BRICK FLOOR ARCH WITH A SMOOTH SOFFIT.

This is done by covering the wood centre, which must have its battens set close together, with paper which is coated on its upper side with a good coat of oil. On this bricks, which can be of any size, are laid dry on edge, which being done the joints are filled in with a thin cement grout thoroughly run in the joints so that it will work under the bottom edges of the brick onto the paper. When the paper and centre are removed the soffits will be found smooth and clean, ready for paint or white-wash.

ROPES.

Table showing what weights hemp rope will bear with safety.

Circumference.	Pounds.	Circumference.	Pounds.
1 inch.	200	3 inch.	18 0
1 $\frac{1}{4}$ "	312.5	3 $\frac{1}{4}$ "	2112.5
1 $\frac{1}{2}$ "	450	3 $\frac{3}{4}$ "	2450
1 $\frac{3}{4}$ "	612.5	3 $\frac{1}{2}$ "	2812.5
2 "	890	4 "	3200
2 $\frac{1}{4}$ "	1012.5	5 "	5000
2 $\frac{1}{2}$ "	1250	6 "	7200
2 $\frac{3}{4}$ "	1512.5		

NOTE.—A square inch of hemp fibers will support a weight of 9,200 pounds. The *maximum* strength of a good hemp

rope is 6,400 pounds to the square inch. Its *practical* value not more than one-half this strain. Before breaking it stretches from one-fifth to one-seventh, and its diameter diminishes one fourth to one-seventh. The strength of manila is about one half that of hemp. White ropes are one-third more durable.

To find the number of bricks in a wall, first ascertain the number of square feet of surface, and then multiply by 7 for a 4 inch wall, by 15 for an 8-inch wall, by 23 for a 12-inch wall, and by 30 for a 16-inch wall.

WOOD TACKLE BLOCKS.

Inside iron strapped, iron hooks, lignumvitæ or iron sheaves.

4 inch shell, for $\frac{1}{2}$ inch rope.

5	"	"	"	$\frac{5}{8}$	"
6	"	"	"	$\frac{3}{4}$	"
7	"	"	"	$\frac{7}{8}$	"
8	"	"	"	1	"
9	"	"	"	1	"

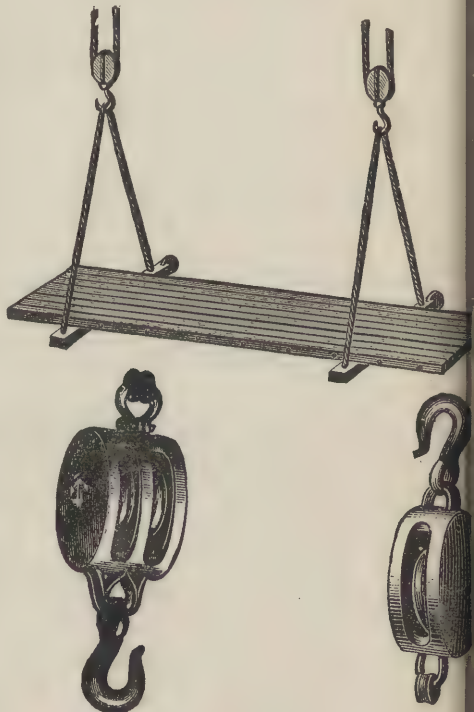


FIG. 129.

SWINGING SCAFFOLD AND TACKLE BLOCKS

The following number of brick are allowed for each square foot of face of wall in measuring brickwork when laid by the thousand by the mason:

Thickness of wall.	No. brick.
4 inches.....	7½
8 ".....	15
12 ".....	22½
16 ".....	30
20 ".....	37½
24 ".....	6
28 ".....	52½
32 ".....	60
36 ".....	67½
42 ".....	75

Cubic yard = 600 brick in wall.

Perch (22 cubic feet) = 550 brick in wall.

To pave one square yard on flat requires 48 brick.

To pave one square yard on edge requires 68 brick.

When washing down brickwork with cement the old joints should be cut out to give a keying for cement about ¼-inch deep.

Hard bricks set in cement and 3 months set, will sustain a pressure of 40 tons per square foot.

SUSTAINING POWER OF SOILS.

Rock, 200 to 205 tons per square foot.	
Gravel, 8 " " " "	"
Sand, 4 " " " "	"
Clay, 4 " " " "	"
Soft Clay, 1 " " " "	"

For mixing concretes or mortars the following will prove useful:

CAPACITY OF BOXES, BINS, ETC.

Length.	Breadth.	Depth.	Will contain Bushels.
5 ft...	3 ft...	2 ft.	24
5 ft...	3 ft...	3 ft.	36
5 ft...	3 ft...	4 ft.	48
7 ft...	5 ft...	3 ft. 9 in.	100
9 ft...	6 ft...	5 ft.	210
12 ft...	8 ft	6 ft.	500

A box four feet eight inches long, two feet four inches wide, and two feet four inches in depth, will contain twenty bushels.

A box twenty-four inches by sixteen inches square, and twenty-eight inches deep, will contain a barrel.

A box twenty-six by fifteen and a half inches square, and eight inches deep, will contain a bushel.

A box twelve inches by eleven and a half inches square, and nine inches deep, will contain a half bushel.

A box eight by eight inches square, and eight inches deep, will contain a peck.

A box eight by eight inches square, and four and one-eighth inches deep, will contain one gallon.

A box four by eight inches square, and four and one eighth inches deep, will contain a half gallon.

A box four by four inches square, and four and one-fourth inches deep, will contain a quart.

NOTE.—A cubical box is one whose length, breadth and depth are equal.

A cubic yard of mortar requires seven bushels of gray lime and twenty three bushels of sand. One-third bulk of water in each case.

The following strengths of masonry material are given in the new Building Code of New York:

	Lbs. per sq. foot.
Concrete (Portland) cement, 1; sand, 2; stone, 4.	230
Concrete (Portland) cement, 1; sand, 2; stone, 5.	208
Concrete, Rosendale, or equal, cement, 1; sand, 2; stone, 4.....	125
Concrete Rosendale, or equal, cement, 1; sand, 2; stone, 5.....	111
Rubble stonework in Portland cement mortar.....	140
Rubble stonework in Rosendale cement mortar.....	111
Rubble stonework in lime and cement mortar.	97
Rubble stonework in lime mortar.....	70
Brickwork in Portland cement mortar: cement, 1; sand, 3.....	250
Brickwork in Rosendale, or equal, cement mortar: cement, 1; sand, 3.....	208
Brickwork in lime and cement mortar: cement, 1; lime, 1; sand, 6.....	160
Brickwork in lime mortar: lime, 1; sand, 4.....	111
Granites (according to test).....	1,000 to 2,400
Greenwich stone.....	1,200
Gneiss (New York City)....	1,300
Limestones (according to test).....	700 to 2,300
Marbles (according to test).....	600 to 1,200
Sandstones (according to test).....	400 to 1,600
Bluestone, North River....	2,000
Brick (Haverstraw, flatwise)	800
Slate.....	1,000

As to the formation and the foundation footings, I would here state that there is never, to my mind, sufficient care devoted to this most important detail, and I would like the following simple rules to be followed:

For sand and gravel the best footing is good base stone, 6 or 8 inches thick, laid edge to edge. For the ordinary 18 or 20-inch walls of a frame house, these should be from 8 to 12 inches thick. For a soft clay mud or sand and mud bottom, Portland cement concrete. For very soft mud, piles should first be driven, spaced about 30 inches on centers, and filled in on top with 12 inches of concrete. For rock the surface of the rock should first be leveled off, and then the holes filled in level with a thick concrete. All footings under piers and posts should be similarly treated. All cellar walls should, if below the ground level, be laid in cement mortar. Nothing is so destructive to the frame of a building as a damp cellar, and, therefore, the floors of all cellars of frame houses should be concreted.

CEMENTS.

All cements on the street in barrels should be kept well covered with planks to prevent its being injured by possible rains.

The practical difference between a Rosendale and a Portland cement is this: Rosendale is a quick setting cement, and the Portland is a slow setting cement, the usual proportion being two of sand and one of cement. Sand is disintegrated sandstone; gravel is disintegrated rock; concrete is a mixture of stone, sand and cement, the proportion being two of sand, one of cement and five of broken stone. In making connection with old concrete the old work should be broken, the dust removed and moistened with water.

Directions for using Superfine Cement—For ordinary hard finish, mix equal parts of best lime putty and Superfine Windsor cement. For polished surface, mix two thirds superfine cement and one-third best white lime putty and trowel to smooth surface. Apply powdered soapstone lightly and quickly one hour thereafter with smooth cotton cloth, waste, or old silk. Under no circumstances should the walls be finished until the browning is thoroughly dry. This cement will cover from 150 to 170 square yards per barrel.

Concrete on top of Terra Cotta Arches.—One part Atlas cement, one

part clean sharp sand, seven or eight parts ashes in bulk; mixed dry, and then wet and turned over.

Brickwork per cubic foot weighs 125 pounds; Indiana limestone masonry weighs 168 pounds; concrete weighs 485 pounds.

Strength of Concrete and Stone Masonry.—Concrete will carry 5 to 15 tons per square foot; rubble will carry 10 to 15 tons per square foot: limestone ashlar will carry 20 tons per square foot; granite ashlar will carry 30 tons per square foot.

SAND.

Clean Sand will not soil the hands when rubbed upon them, and the presence of salt can be detected by its taste.

Sand is argillaceous, siliceous or calcareous, according to its composition. Its use is to prevent excessive shrinking and to save cost of lime or cement. Ordinarily it is not acted upon by lime, its presence in mortar being mechanical, and with hydraulic limes and cement it weakens the mortar.

It is imperative that sand should be perfectly clean, free from all impurities, and of a sharp or angular structure. Within moderate limits, size of grain does not affect the strength of mortar; preference should be given to coarse calcareous sand, as it is preferable to siliceous.

The best sharp sands have diamond shaped particles. Quick sands have round particles.

In order to protect iron and steel from the injurious action of the atmosphere or in electric light stations, where the deteriorating action of the electric fluid communicates to the iron and steel a disease called Electrolysis the metal is enclosed with a covering of brick, terra cotta or porous clay blocks which are cut and set by bricklayers. Reference to the diagrams in manufacturers' catalogues will clearly explain how they are placed.

A good laborer will dump, wet and mix from 15 to 20 barrels of lump lime in eight hours.

A brick on flat as laid in the wall has two-thirds more strength than when laid on edge, hence the objection to "rowlocks," as they are termed, in walls and piers, but if a brick is supported at both ends, then it has more bearing strength on edge than on flat.

BRICK MANHOLES AND BRICK SEWERS.

These too are constructed of circular and egg-shaped sections by the bricklayer, who lays the brick in rings or continuous rowlocks of brick until the full thickness is built. As this work involves no detail which is not contained in the methods already described, I will conclude by referring the reader to the details of this form

of construction contained in my book, "PRACTICAL CENTRING," where this and other important subjects in connection with masonry construction are treated at length; also by recommending all readers to study all details of brick, terra cotta and cement manufacturers, as from them they will gain much valuable information regarding modern masonry construction.

MANILA-ROPE.

All Manila-rope ought to be made out of pure Manila-hemp, and of the best quality.

For information is subjoined the following estimate of weight:

Size in diameter, inch.....	$\frac{1}{8}$	$\frac{5}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1
Weight of 100 feet, pounds.....	3	4	5 $\frac{1}{2}$	8	15	17	25	33
Strength of new rope, pounds.....	450	750	900	1700	3000	4000	5800	7000
Price, in full coils of 1000 feet, $\frac{3}{8}$ inch and smaller.....	Per pound, \$.....							
Larger than $\frac{3}{8}$ inch.....	" "							
Price, cut, $\frac{3}{8}$ inch and smaller.....	" "							
Larger than $\frac{3}{8}$ inch.....	" "							

NUMBER BRICKS REQUIRED TO CONSTRUCT ANY BUILDING.

(Reckoning 7 bricks to each superficial foot.)

Superficial ft. of wall.	Number of Bricks to Thickness of					
	4 in.	8 in.	12 in.	16 in.	20 in.	24 in.
1	7	15	23	30	38	45
2	15	30	45	60	75	90
3	23	45	68	90	113	135
4	30	60	90	120	150	180
5	38	75	113	150	188	225
6	45	90	135	180	225	270
7	53	105	158	210	263	315
8	60	120	180	240	300	360
9	68	135	203	270	338	405
10	75	150	225	300	375	450
20	150	300	450	600	750	900
30	225	450	675	900	1,125	1,350
40	300	600	900	1,200	1,500	1,800
50	375	750	1,125	1,500	1,875	2,250
60	450	900	1,350	1,800	2,250	2,700
70	525	1,050	1,575	2,100	2,625	3,150
80	600	1,200	1,800	2,400	3,000	3,600
90	675	1,350	2,025	2,700	3,375	4,050
100	750	1,500	2,250	3,000	3,750	4,500
200	1,500	3,000	4,500	6,000	7,500	9,000
300	2,250	4,500	6,750	9,000	11,250	13,500
400	3,000	6,000	9,000	12,000	15,000	18,000
500	3,750	7,500	11,250	15,000	18,750	22,500
600	4,500	9,000	13,500	18,000	22,500	27,000
700	5,250	10,500	15,750	21,000	26,250	31,500
800	6,000	12,000	18,000	24,000	30,000	36,000
900	6,750	13,500	20,250	27,000	33,750	40,500
1,000	7,500	15,000	22,500	30,000	37,500	45,000

CUBIC YARDS OF EARTH IN DITCHES WITH SIDE SLOPES OF ONE FOOT IN TEN.

Bottom Width.	Depth in Feet.								
	4	6	8	10	12	14	16	18	20
2 feet.....	.36	0.60	0.86	1.15	1.46	1.80	2.19	2.59	2.96
2½ ".....	.44	0.71	1.01	1.33	1.68	2.06	2.48	2.92	3.33
3 ".....	.51	0.82	1.16	1.51	1.90	2.32	2.80	3.25	3.70
3½ ".....	.59	0.93	1.30	1.70	2.12	2.58	3.10	3.58	4.07
4 ".....	.66	1.04	1.45	1.88	2.34	2.84	3.40	3.91	4.44
4½ ".....	.74	1.15	1.60	2.07	2.57	3.10	3.70	4.24	4.81
5 ".....	.81	1.26	1.75	2.25	2.80	3.36	4.00	4.57	5.18

CARRYING CAPACITY OF SEWER PIPES.

Gallons per minute.

Size of Pipe.	1 inch fall per 100 feet.	3 inch fall per 100 feet.	6 inch fall per 100 feet.	1 foot fall per 100 feet.	2 feet fall per 100 feet.	3 feet fall per 100 feet.
3 inch.....	13	23	32	46	64	79
4 ".....	27	47	66	93	131	163
6 ".....	75	129	183	258	364	450
8 ".....	153	265	375	529	750	923
9 ".....	205	355	503	711	1006	1240
10 ".....	267	463	655	926	1310	1613
12 ".....	422	730	1033	1468	2076	2554
15 ".....	740	1282	1818	2464	3617	4467
18 ".....	1168	2022	2860	4045	5704	7047
24 ".....	2396	4152	5871	8303	11744	14466
30 ".....	4167	7252	10557	14504	20516	25277

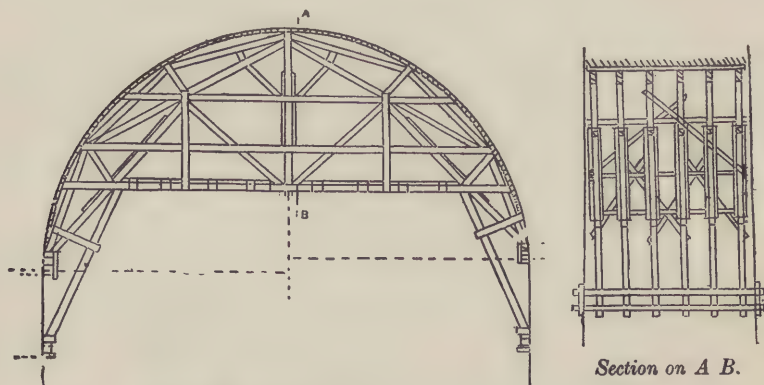


FIG. 130.—CENTRE FOR HEAVY BRICK ARCH.

PART II.

SHORING, NEEDLING AND UNDERPINNING.

CHAPTER I.

SHORING AND NEEDLING.

IN town and city work, as well as very often in the country, the builder finds it necessary to "shore" or "needle" up the walls of an old or a new building, and he is, therefore, interested in knowing how such work is done and the best methods in vogue in this particular line. The information which follows has been gathered by the author during a period of several years and the methods described represent current practice for such work.

With regard to the word "shore," we find by reference to Webster's Dictionary that the noun in its technical sense means "a prop or timber placed as a temporary brace or support on the side of a building." The verb is "to support by a post or buttress; to prop." We will, therefore, proceed to describe the best methods of shoring, or temporarily propping up, walls. Different walls require different methods of shoring, according to the position and condition of the wall or walls and the manner in which they must be sustained. This must be the first consideration before commencing the actual work of placing the shores. This fact being determined, it follows that the builder must with the architect make a very careful examination of the work to be sustained in order to ascertain its condition and the amount of shoring required, so that the sizes and quantities of timbers may be obtained. In joint consultation they will also arrange for the placing of the timbers. All this can only be done by a close scrutiny of the wall and its requirements.

When a wall is so much out of plumb that it is liable to topple over or out, it should be shored or tied in such a way as to prevent its falling. As we are dealing entirely with shoring, we will consider that it is necessary to do this from the outside of the wall. When a wall is as much as $\frac{1}{4}$ inch in every foot

of its height out of plumb it is in a dangerous condition and should be condemned as such, for the reason that as it is gradually moving outward, it will eventually fracture at some point and collapse. To prevent this shores should be inserted.

In the first example we will suppose a piece of wall to be perfectly sound, or a composite whole, with bonds adhering, which by reason of the slipping of the foundation or otherwise is gradually settling out of plumb and leaning over. It will then be necessary to truss or

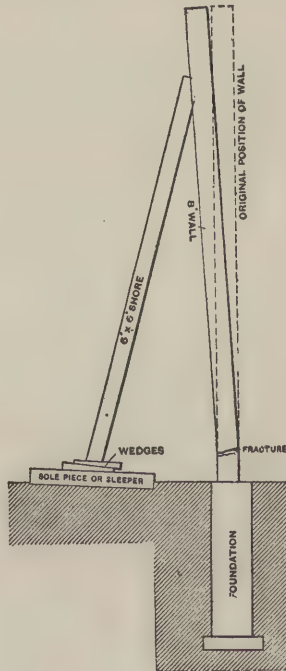


FIG. 1.

support the wall about three-quarters of its height from the top, as illustrated in Fig. 1. The best method of closing:

this would, of course, be to set the shore at right angles, or square to the face of the wall. This not being practicable on account of the absence of a solid body opposite, against which to rest the end of the Shore, or Spreading Brace, it becomes necessary to employ a Raking or "Spur" Shore as an extemporized buttress, and this spur brace is generally a good sound spruce or yellow pine timber.

In order to prevent its upper end from slipping, a hole or notch is cut out, off the face of the wall, and the top is inserted in the breastwork. The bottom end is set on two reversed wedges, which rest on a good block of timber embedded solidly in the ground. By driving the wedges the top end of the brace is forced tightly into the notch in the wall, thus securing the wall firmly in position and preventing its overturning.

Spur braces of this description should be of sufficient thickness that they will not bend when wedged tightly, and if the wall be very thick or heavy, two or more may be inserted in order to secure it safely.

At Fig. 2 several shores are shown applied in this manner, as the wall being dangerously bulged at the several floors

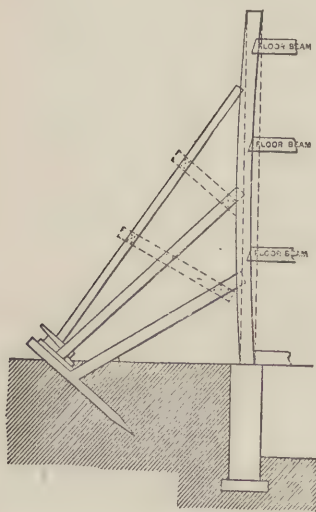


FIG. 2.

it is necessary to use three shores, and holes are cut in the face of the brick-work as before, to secure the upper

ends, while the bottom ends rest on a sole plate, or plates, solidly embedded in the ground. Two or more shores may be tied together by pieces of timber, bolted or spiked on their sides in the way indicated by the dotted lines in Fig. 2.

The following table gives dimensions for Raking or Spur Shore timbers, of spruce or yellow pine:

For walls from	Inches.	Inches
15 to 20 feet in height,	4 x 4 to 6 x 6	
20 " 30 "	4 x 8 " 6 x 8	
30 " 40 "	6 x 8 " 8 x 10	
40 " 50 "	8 x 8 " 10 x 10	
50 " 75 "	10 x 12 " 12 x 14	

Beyond this height combinations of shores must be used. "Fly Shores," or Spreading Braces, as they are frequently termed, are those placed between two walls to prevent them from bulging or falling towards each other. Fig. 3 represents a good example of this work, consisting of six spreaders, or Spreading Braces, inserted from the floors of the old building as it was demolished. The width between the walls was 33 feet, and the shores wedged themselves tightly from wall to wall, each abutting against a stout 3 x 8 timber, and driven to a solid bearing with sledges. The timbers measured 8 x 8 inches, and were prevented from sagging by diagonal braces, framed in under them and spiked. The left hand wall was also needed in order to rebuild its foundation, as will be described in "Underpinning." The right wall had one Raking shore, as indicated in engraving. Before commencing to shore up a solid front wall for the insertion of a breast-summer beam with its supporting columns, the whole front must be carefully looked over to see how it is built, and how the parts are to be supported. Figs. 4 and 5 represent the front of the Hotel Colonial, at corner of 125th Street and Eighth Avenue, New York City. A consideration of this wall, as shown, revealed the fact that the piers would have to be separately supported; likewise the floor beams, which rested on the wall to be removed. To do this a sole piece, or bottom timber, was placed inside on the floor, running parallel to the wall about two feet from it; the floor being shored from the cellar floor below. A similar piece was set on the sidewalk outside about three feet from the wall.

Directly under the centre of each pier, 12 inches above the top line where the breast-summer would rest, a hole

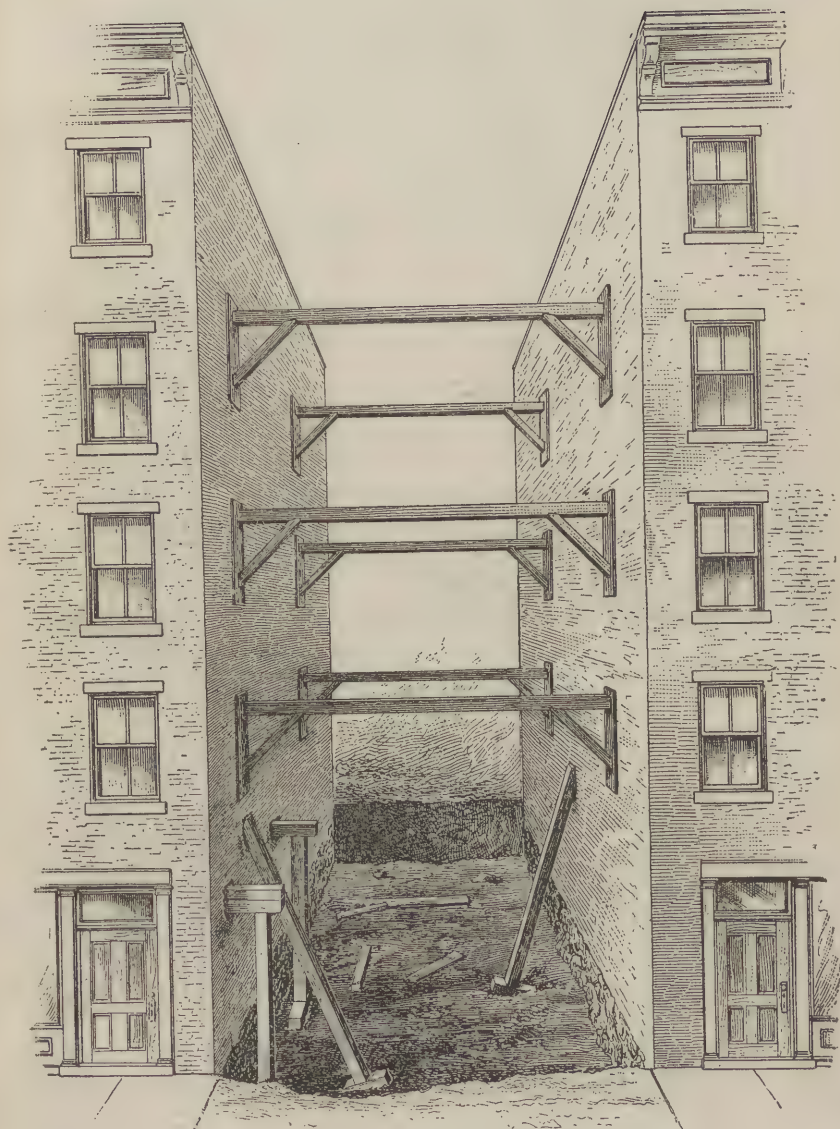


FIG. 3.

was cut through by means of a hammer and cold chisel. This was done in such a way as to leave the top side of each

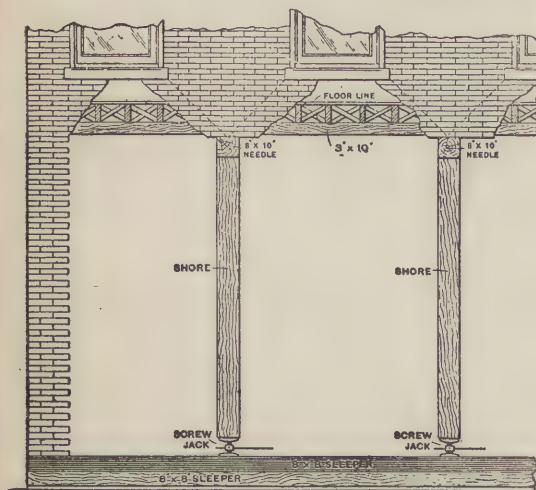


FIG. 4.

hole with a smooth brick face. The hole was about 12 inches square. In it a stout 8 x 8 timber, or needle, was in-

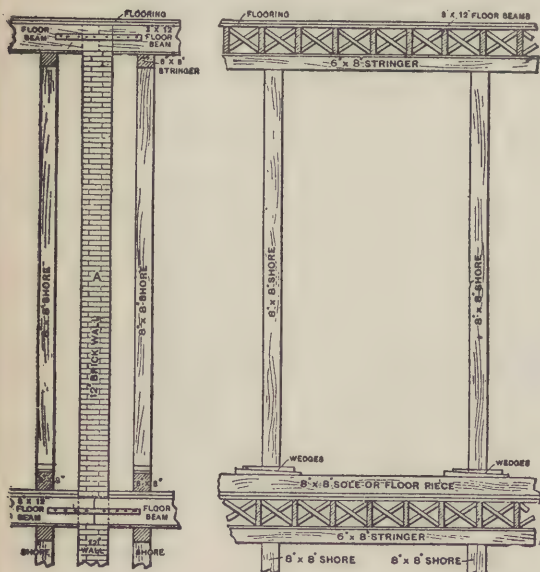


FIG. 5.

serted, and shores placed under it resting on screws or jacks. These being turned up with an iron lever, raised the

shores until they pressed solidly against the needles and entirely resisted or carried the weight of the wall piers above. A 3 x 10 foot spruce timber was placed under the floor beams, resting solidly on the needle, and supported them in an immovable manner.

In Fig. 6 is illustrated an excellent job of shoring which was done at the corner of 125th Street and Fifth Ave-

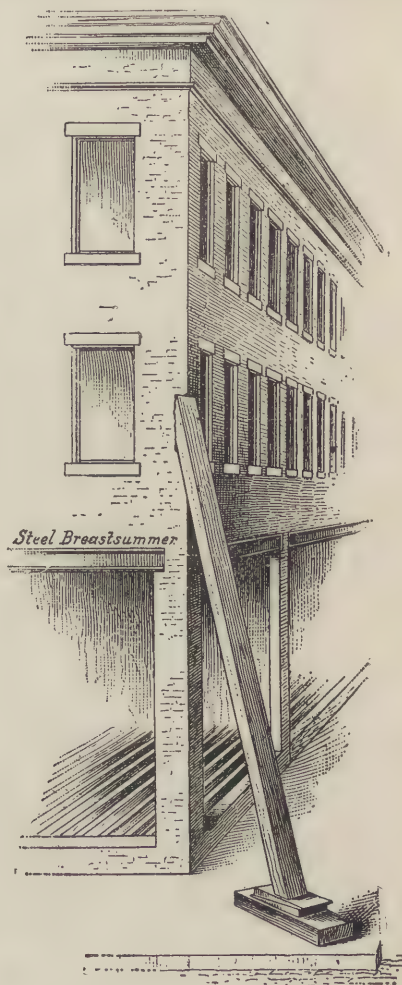


FIG. 6.

nue, New York, where two private houses were remodeled into stores, by doing away with the stoops and basements. Here the same system was followed, with the addition of the Raking corner shore.

This was placed in the angle of the wall, resting on a block and wedges set on the sidewalk. The shore was inserted for the purpose of preventing the corner from springing out while the breast-summers were being inserted and the pier rebuilt underneath them.

The appliances necessary to do the work consist of the timbers to form the shores and needles, wedges and screw jacks. The timbers may be of spruce or yellow pine, but the wedges are best made of oak. In Fig. 7 is illus-

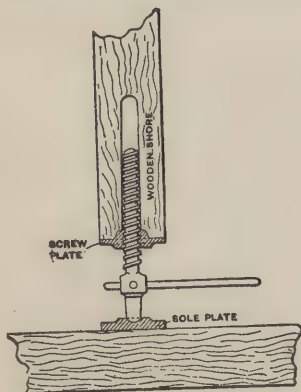


FIG. 7.

trated a screw jack employed for this kind of shoring. As will be seen, it consists of an iron shoe, or sole plate, which rests directly on the timber placed on the sidewalk and a revolving screw, which has its bottom end turning in a conical step in the shoe, and revolves in an upper plate on which the bottom end of the shore rests, the shore being bored out to admit the screw and allow the shore to slide up or down. The screw is turned by means of an iron bar, or lever, as shown. This Builders' screw, or pump screw, as it is sometimes termed, is the best and safest for placing under shores, being preferable to what is commonly known as a lifting jack for the reason that it cannot possibly fall or kick over sideways. The lifting jack is, however, extremely useful for the purposes where that shown in Fig. 7 would be unsuited. Both these appliances are easily obtained, and run in sizes as follows:

REGULAR SIZES.

Height when screwed down:
10, 12, 14, 16 inches.

Total rise of screw:
4½, 6½, 8½, 11½ inches.

Diameter of screw:
1½, 1½, 1½, 1½ inches.

HEAVY.

Height when screwed down:
10, 12, 14, 16 inches.

Total rise of screw:
7, 8, 9, 11 inches.

Diameter of screw:
1½, 1½, 1½, 1½ inches.

EXTRA HEAVY.

Height when screwed down:
12, 14, 16 inches.

Total rise of screw:
8, 9, 10½ inches.

Diameter of screw:
1¾, 1¾, 1¾ inches.

When it is desired to remove an inside, or party, wall to obtain an enlarged floor, the floor timbers resting on it will require to be upheld by shoring before it is removed.

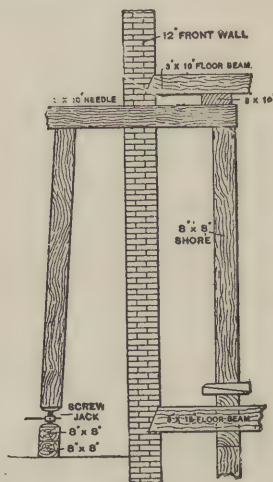


FIG. 8.

In Fig. 8 builders will recognize a job of this kind, where it is desired to remove a 12-inch brick wall and substitute for same a steel girder supported by cast iron columns. Shores 8x8 inches in size are used, resting on 8x8 inch longitudinal timbers and driven tightly against the plate with oak wedges. If the walls are continuous from one floor to that above, the upper part of the wall will require needling as well as shoring. In raising roofs or floors the lifting jack screw is employed, and blocks laid crosswise on top of each other are placed under the jacks before commencing operations.

Fig. 9 shows how the centre pier of an old building was removed by first needling and shoring and the steel breast-summer girder shown in the engraving inserted, with its ends resting on the two outside piers, which were provided with granite templets to properly sustain the vertical pressure.

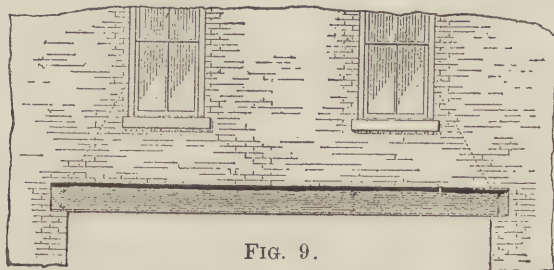


FIG. 9.

Fig. 10 represents a simple way of needling up a wall for the purpose of holding it in a safe manner till it is altered or underpinned. The usual spur shore is placed against the outside face of the wall, to prevent its springing out with its footplate and oak wedges, and

than 6 feet apart at the most, and the spur shore should be a stout stick heavy enough to carry, when notched, the full weight to be borne.

An unusual form of shoring and one which will be found very economical and applicable, is that illustrated at Fig. 11. Here a section of two (east

and west) 12-inch party walls are shown looking towards the front, the building between them having been pulled down. The footings of the two walls are carried on a stout 14 x 14 yellow pine cantilever needles resting on stringer and blockings, this being done for the purpose of

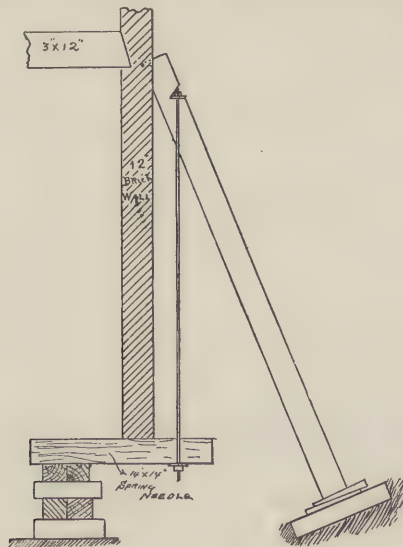


FIG. 10.

from this the outside end of the needle is held up to sustain the wall, the inside end resting on 12 x 12 blocks built up in the ordinary way. The iron suspension rods are each 1 inch thick, and tapped top and bottom ends for plates and nuts. These spring needles must be kept very close together, not more

underpinning the party foundation by building it down in sections between them. The party walls are prevented from spreading by spurs set on the cantilevers at the first story, and above by Raking spreaders tightly wedged against face timbers, all being spaced about 8 feet apart.

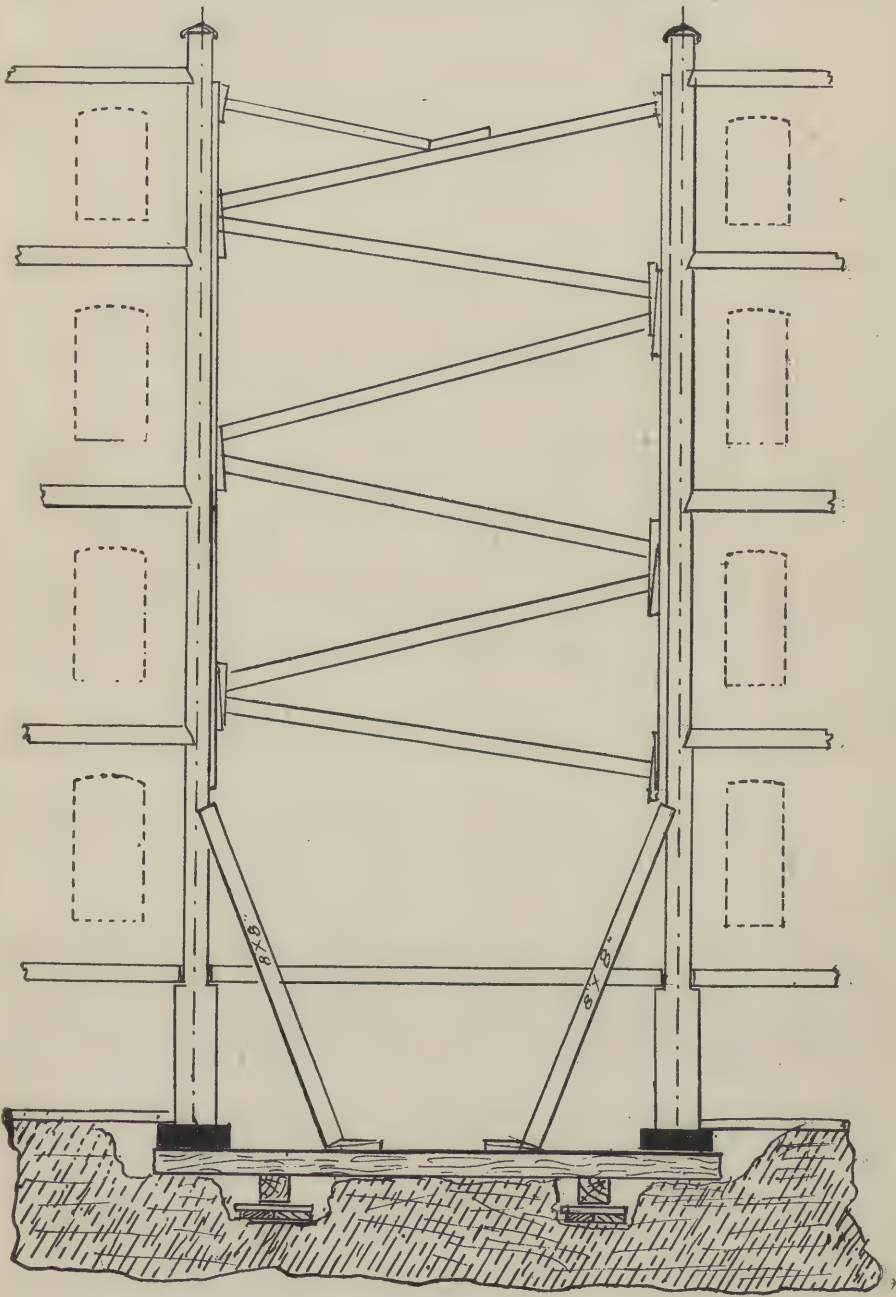


FIG. 11.

CHAPTER II.

UNDERPINNING AND SHEET PILING.

IT often happens that the foundation of a new building is to be constructed close to an adjoining structure, the footings of which have not been carried down to the depth that is required for the new building. If the soil or bottom upon which the existing building rests is soft clay and sand, gravel, loose sand, or in fact any soft soil that would be liable to compress, crush, or subside when the excavations for the new building are proceeding, then proper precautions must be taken to preserve the old or existing building from injury and prevent it from suddenly settling and thus causing the walls to fracture or collapse. Such a condition of affairs is shown in Fig. 12. In this case the bottom of the excavation for the new building is 10 feet below the curb line, while the footing of the old building is only 4 feet from the curb line. From this figure it can readily be seen that the wall of the old building would crush the earth underneath its footings, after the excavation for the new foundation had been made. To avoid such a disaster, builders and house shorers place temporary supports underneath the walls of the old building, so that they will be safely carried until a new foundation can be built. The purpose of such shores is usually to support the old wall until the new foundation can be built from the bottom of the excavation up to the old footings.

This question of UNDERPINNING is one that is of great interest to architects and owners, for many important legal cases have had their origin in a plea for damages instituted by owners whose buildings were ruined by carelessness in excavating for the foundations of adjacent buildings. In large cities the importance of protecting existing structures from damage caused by adjacent building operations became evident to the lawmakers, and laws and ordinances governing such cases were drawn up and adopted, and in most cases rigorously enforced; so that I here reproduce the following quotation from the complete laws of New York, which show conclusively the extent and purpose of such an ordinance, and show the reader how important it is to provide adequate methods of underpinning.

EXCAVATIONS AND FOUNDATIONS.

"Sec. 22. *Excavations.*—All excavations for buildings shall be properly guarded and protected so as to prevent the same from becoming dangerous to life or limb and shall be sheath-piled where necessary to prevent the adjoining earth from caving in, by the person or persons causing the excavations to be made. Plans filed in the Department of Buildings shall be accompanied by a statement of the character of the soil at the level of the footings.

"Whenever an excavation of either earth or rock for building or other purposes shall be intended to be, or shall be carried to the depth of more than ten feet below the curb, the person or persons causing such excavation to be made shall at all times, from the commencement until the completion thereof, if afforded the necessary license to enter upon the adjoining land, and not otherwise, at his or their own expense preserve any adjoining or contiguous wall or walls, structure or structures from injury, and support the same by proper foundations, so that the said wall or walls, structure or structures, shall be and remain practically as safe as before such excavation was commenced, whether the said adjoining or contiguous wall or walls, structure or structures, are down more or less than ten feet below the curb. If the necessary license is not accorded to the person or persons making such excavation, then it shall be the duty of the owner refusing to grant such license to make the adjoining or contiguous wall or walls, structure or structures, safe, and support the same by proper foundations so that adjoining excavations may be made, and shall be permitted to enter upon the premises where such excavation is being made for that purpose, when necessary. If such excavation shall not be intended to be, or shall not be, carried to a depth of more than ten feet below the curb, the owner or owners of such adjoining or contiguous wall or walls, structure or structures, shall preserve the same from injury, and so support the same by proper foundations that it or they shall be and remain practically as safe as before such excavation was commenced, and shall be permitted to enter upon the premises where such excavation is being made for that purpose, when necessary.

"In case an adjoining party wall is intended to be used by the person or persons causing the excavation to be made, and such party wall is in good condition and sufficient for the uses of the adjoining building, then and in such case the person or persons causing the

said premises in the same manner as if he had been employed to do the said work by the said person or persons. When an excavation is made on any lot, the person or persons causing such excavation to be made shall build, at his or their own cost and expense, a retaining wall to support the adjoining earth, and such retaining wall shall be carried to the height of the adjoining earth, and be properly protected by coping. The thickness of a retaining wall at its base shall be in no case less than one-fourth of its height."

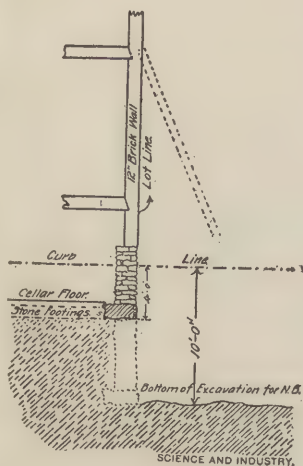


FIG. 12.

excavations to be made shall, at his or their own expense, preserve such party wall from injury and support the same by proper foundations, so that said party wall shall be and remain practically as safe as before the excavation was commenced.

"If the person or persons whose duty it shall be to preserve or protect any wall or walls, structure or structures, from injury shall neglect or fail so to do, after having had a notice of twenty-four hours from the Department of Buildings, then the Commissioner of Buildings may enter upon the premises and employ such labor, and furnish such materials, and take such steps as, in his judgment, may be necessary to make the same safe and secure, or to prevent the same from becoming unsafe or dangerous, at the expense of the person or persons whose duty it is to keep the same safe and secure. Any party doing the said work, or any part thereof, under and by direction of the said Department of Buildings, may bring and maintain an action against the person or persons last herein referred to, to recover the value of the work done and material furnished in and about the

When the excavation for a new building is being executed it is the duty of the contractor or his foreman to stop the excavation at the bottom of the stone or concrete footings of any or all contiguous buildings, and the excavations should not be allowed to proceed until the foundation walls and footings of buildings that are liable to damage have been properly and thoroughly protected, either by temporary shoring, needling, or by thorough underpinning. The best way to protect the foundations of a building having solidly-built walls and where the footings are some distance above the bottom of the excavation, is to insert timber needles through the wall, either under the base stone or the concrete footings. If the walls are

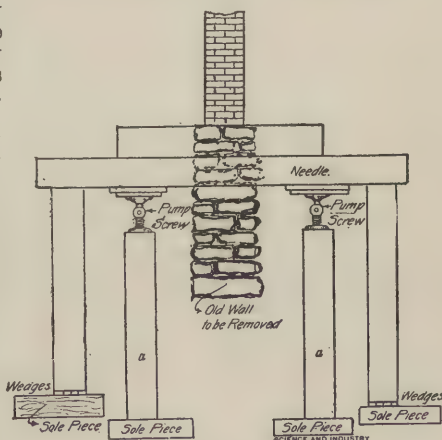


FIG. 13.

to be underpinned with a continuous stone or brick underpinning, they may be needled under the superimposed brickwork at the top of the stone foundation work, as shown in Fig. 13.

In this figure the needle is re-enforced or stiffened by a second timber placed on its upper side, to prevent sagging under the weight of the wall. The shores or uprights are likewise often doubled, in order to guard against any settlement at the sole pieces, or plates. In such a case two sets of uprights are used, one set having pump screws and the other being provided with wedges so that should settlement take place in the inner shores, or those marked *a, a*

needles show any indications of buckling or bulging. raking or spur shores may be placed at the second or third-story tier of beams. These props will steady the wall and prevent any danger of collapse.

The illustration of Fig. 14 shows a good method of combining blocking, needling, and shoring for the purpose of underpinning the wall without encroaching upon the built and occupied premises. In this figure the cantilever

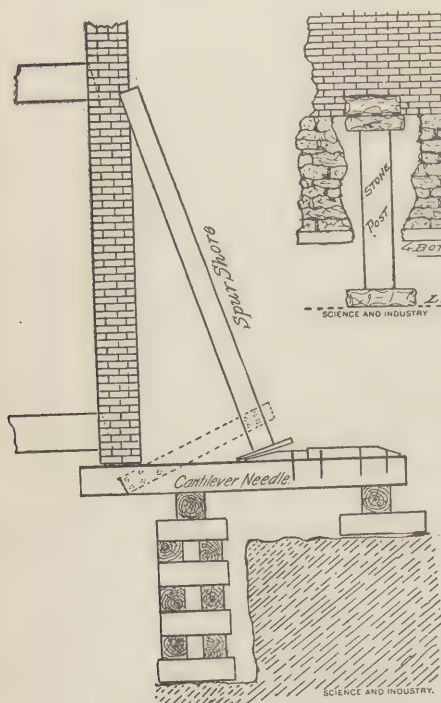


FIG. 14.

in Fig. 13, the wedges under the outside ones can be driven up tight, thus relieving the inner shores of much of the weight. The needles and shores should be kept from 6 to 8 feet apart and set level and plumb, likewise solid. When sufficient needles are inserted in the manner described, the wall will corbel or arch itself between them, and the intervening stonework may be removed, the new foundation wall being built up from the bottom of the excavation, as shown by the dotted lines in Fig. 12. Should the wall that is supported upon

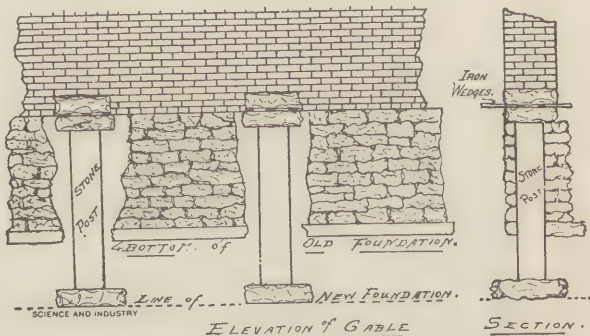


FIG. 15.

or needle is a strong 12" \times 12" oak or yellow-pine timber, resting upon the blocking which is placed upon the firm bottom of a trench or hole dug to the same level as the new adjoining excavation. The blocking is located at about one-fourth the length of the cantilever or needle beam from its end, the beam being held in equilibrium by the spur or raking shore that has its upper end set in the wall at the second-story tier of floorbeams. The spur or raking shore, besides holding the needle beam in equilibrium, also prevents the wall from bulging. The bottom end of the shore is prevented from slipping by the heavy oak blocks and wedges shown in Fig. 14. For further security against slipping, stout 2-inch braces or tiers are often nailed or spiked to each side of the brace or needle.

Many contractors follow the method of underpinning illustrated in Fig. 15, and where this is employed no shoring or needling need be used, since the wall is supported directly from the bottom of the adjoining excavation on granite or iron posts. These posts or supports are inserted in recesses, or chases, cut out of the old wall to admit them. This can safely be done, as the brickwork corbels or arches itself between the in-

serted supports. Where such methods of procedure are employed, the posts are set on stone bases of sufficient area and capped with two bluestone plates or station templets, the wall being brought to a bearing upon the posts by driving wrought-iron wedges

cement mortar before being wedged up tightly. The writer has seen many gable walls safely underpinned by this method, and remembers that in one case the posts used were old front first-story columns that had only supported a granite lintel in the old fashioned way

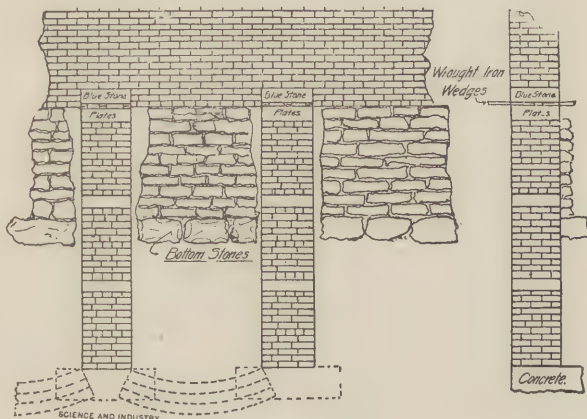


FIG. 16.

between the templets until the maul rebounds and they cannot be driven any farther. The templets must in all cases be bedded in good strong Portland

still to be seen in many existing buildings constructed previous to the extensive introduction of cast-iron columns. When the excavation is carried down to a great depth, it is necessary to use brick piers with mortar instead of granite or cast-iron posts, and when such piers are used care must be taken to see that they have sufficient sectional area to fully support the loads coming upon them from the building.

Fig. 16 shows the method of underpinning by use of brick piers well bonded. In this case the bottom of the excavation of the new building is so far below the old footings that the rough rubble wall forming the old foundation had better be removed and the sides between the piers filled in with a light retaining wall of stone or brick. Should the bottom of the excavation for the piers prove to be of soft earth, it may be necessary to distribute the weight of the building by footings consisting of grillage, ranging timbers, or inverted arches. Where such a condition exists, the special foundation should be put in place before the piers are built in, and such shoring and needling as will be necessary should be provided. It can readily be seen that such foundations, and especially the inverted arches, could not be safely built without first supporting the old work above. The

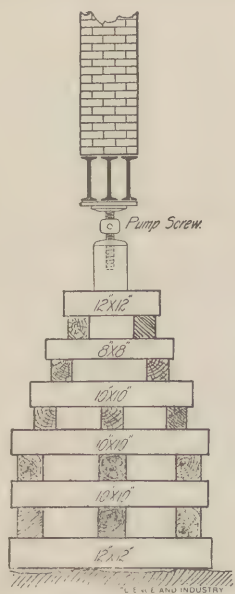


FIG. 17.

dotted lines in Fig. 16 show the inverted arches and also the concrete footing. Before the wedges between the templates on the top of the brick piers are driven tight, the mortar in the piers must be given ample time to set, in order that full strength of the brickwork may be realized before they are subjected

liable than vertical shores supporting horizontal needles, because, on account of the increased area of the base, there is less lateral movement. It is really the only method to employ where the entire story is to be removed in order to make alterations, but it has the disadvantage of taking up space and requir-

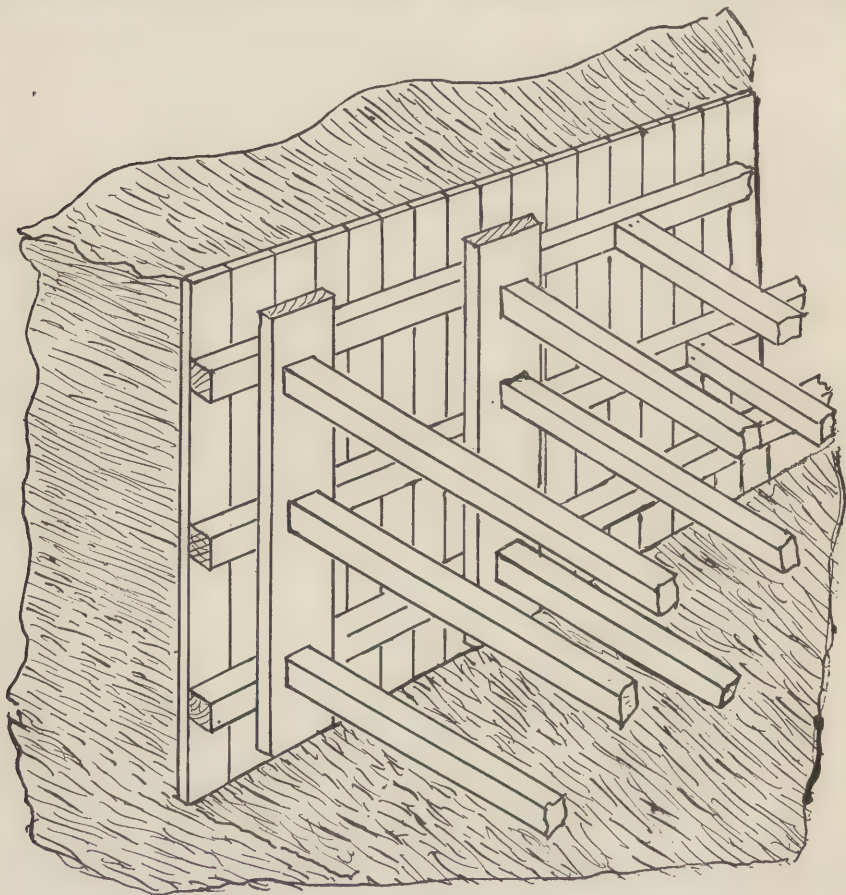


FIG. 18.

to the weight from above. It is a good practice and a precaution that should never be neglected, to lower the shoring under needling very gradually, so that no sudden shock will come upon the new work.

Fig. 17 illustrates clearly the method by which a girder may be supported upon a grillage of heavy timbers laid across each other at right angles. If the blocks are available and of regular sizes, this method is safer and more re-

ing considerable material in the way of timber.

In conclusion, the writer would impress upon all those engaged in the practice of architecture or building operations the importance of observing every precaution for the preservation of foundations supporting the adjacent buildings. The careful consideration of this subject is of pre-eminent importance at the beginning of the twentieth century, when buildings of great height

and weight are often erected adjacent to or between low and light buildings, and should there be no precaution taken, it is not only possible but highly probable that the result will be disastrous, for the heavy mass of the greater structure will drag down and injure the smaller one. This is especially the case where the composition of the earth under the footing is of a compressible nature. The proper consideration of foundations and footings has never required more skill and care in the history of building construction than it does now, and should never for any reason be neglected.

SHEET PILING.

By this is meant the method employed by engineers and constructors to properly support sidewalk banks of streets, clay, sand or filled in, or any bank, while excavating for cellars, walls, trenches, caissons, or any purpose where it is necessary to keep the bank vertical after it is excavated, to prevent its cav-

ing in on the men working, or the materials placed below. This is done by driving down 2 or 3-inch planks placed edged, in the manner seen in Fig. 19. Across the inside of these stout timbers stringers are set, being held in place by upright battens, which receive the thrust of spreading shores, abutted and wedged tightly, to prevent the pressure of the earth from pushing the timbers out. The bottom end of the spreaders are either set against a stout sole ground piece of timber or against an opposite bank, as done in the excavating of deep trenches, etc., for footings of foundation walls, piers, etc. All materials for sheet-piling, shores, breast-timbers, foot blocks, wedges, screws, etc., ought to be of good sound materials of ample strength to safely sustain all the weight and use that they may be called upon to bear.

The placing of sheet-piling, timbers, etc., should be in such position as not to interfere with the placing of walls and columns or footings of same.



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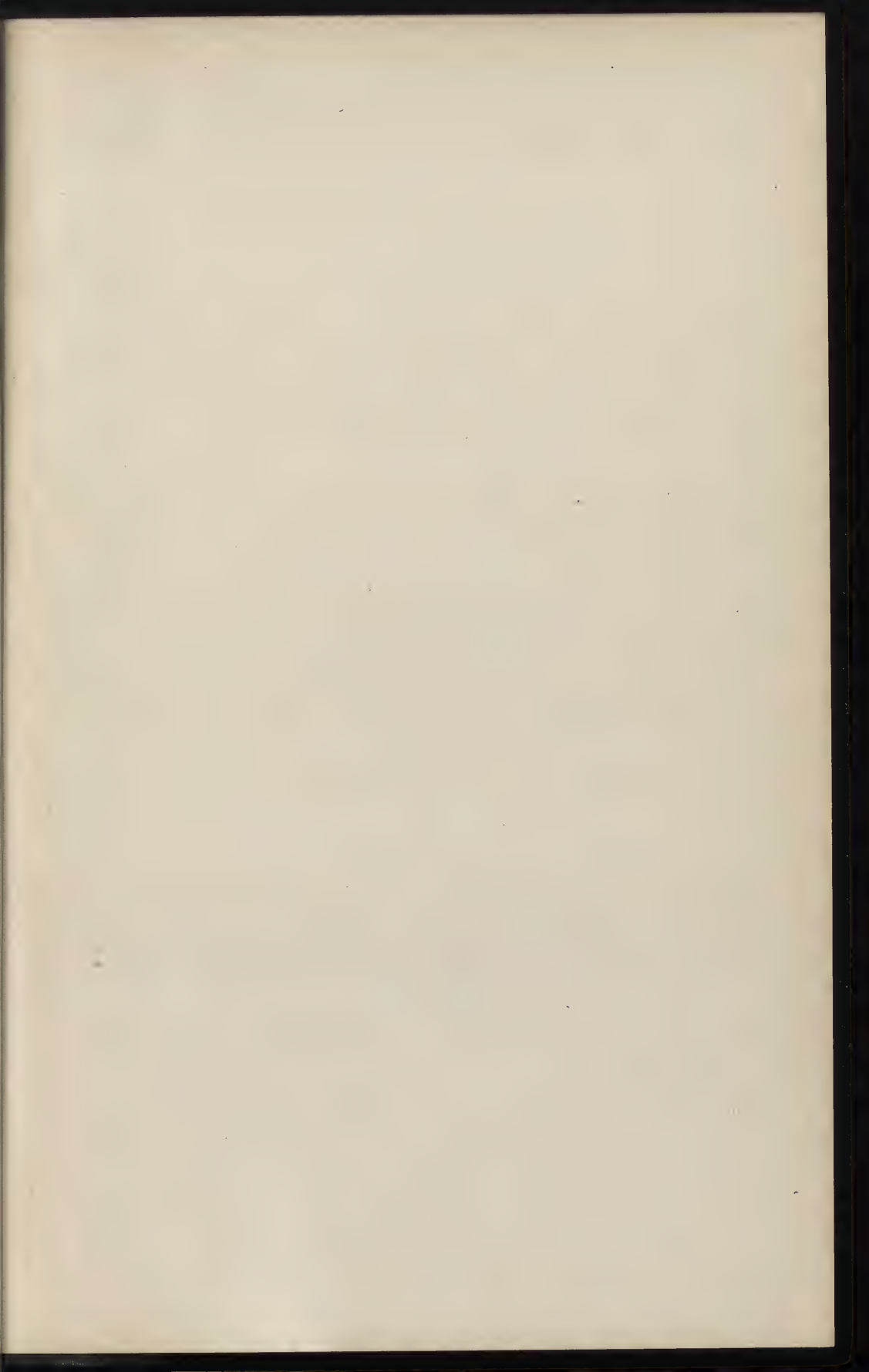
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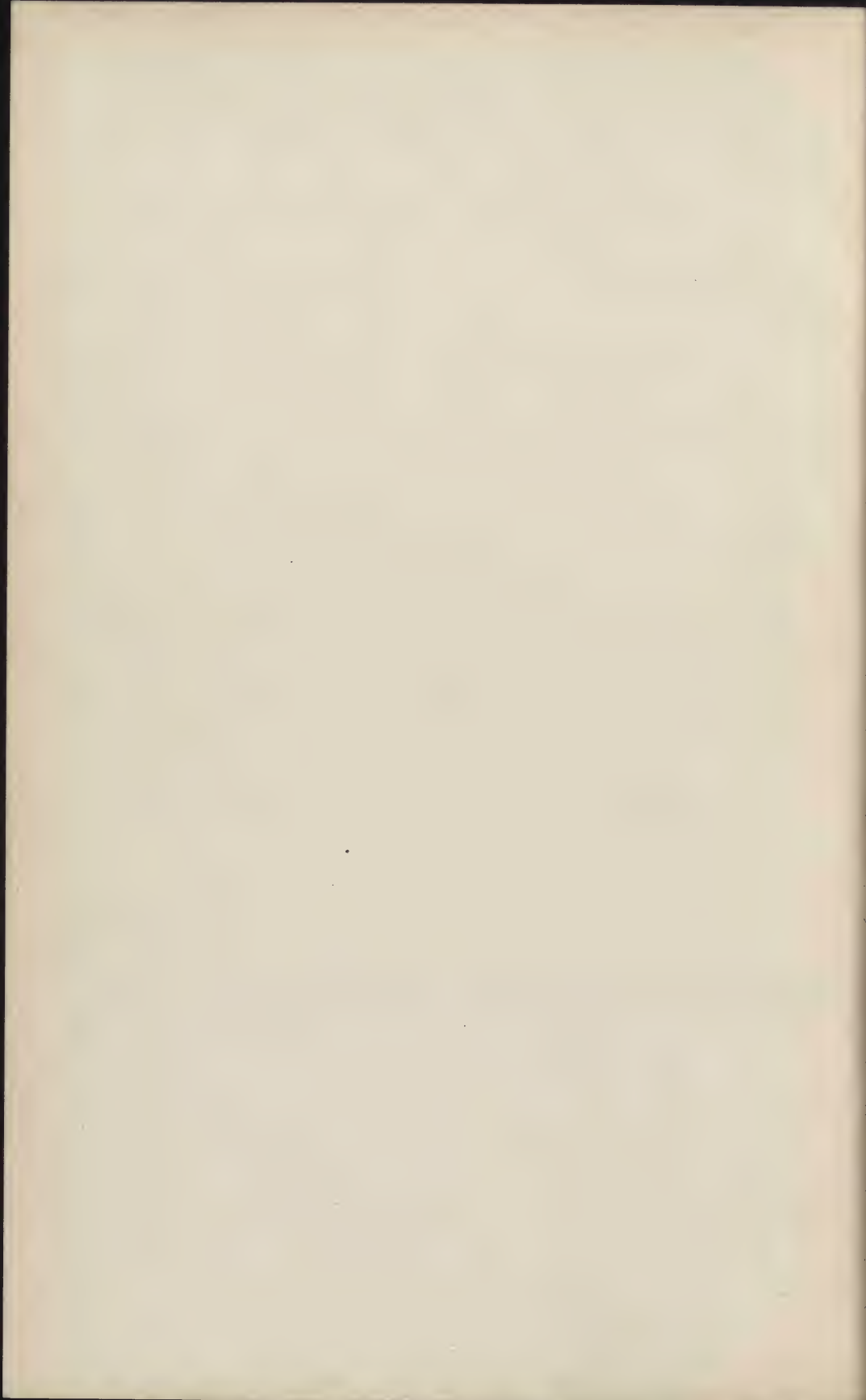
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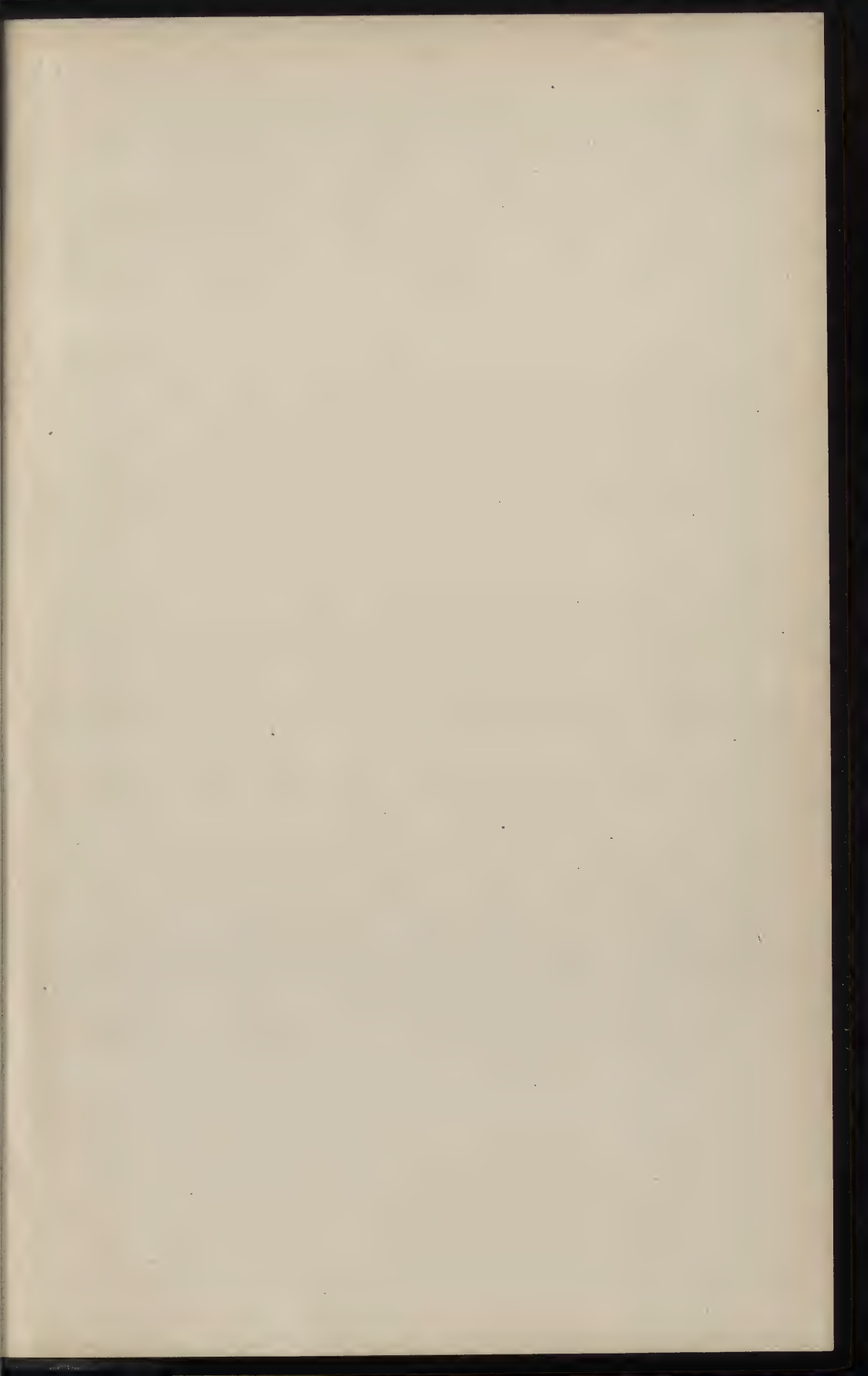
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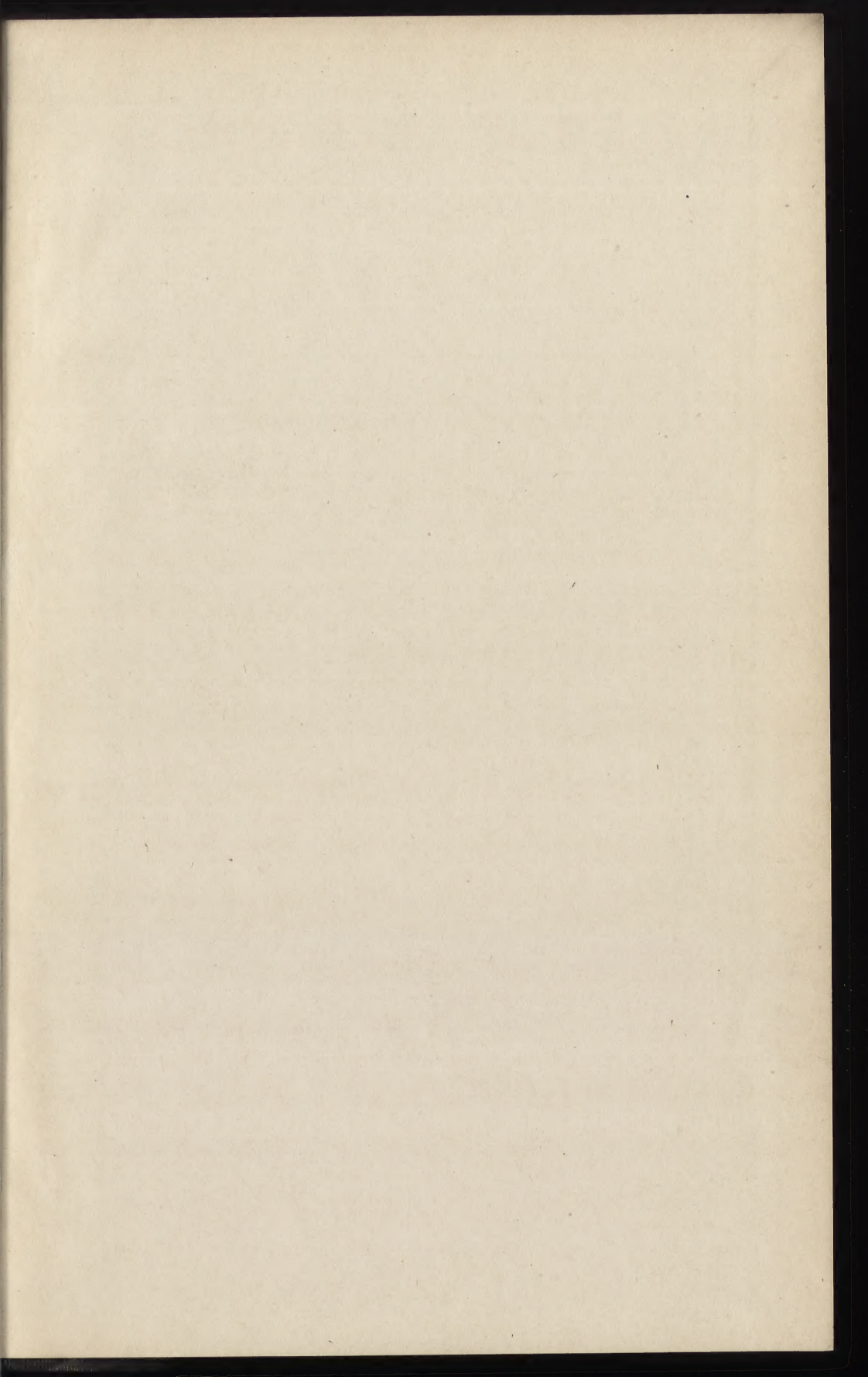
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